IFW 1/26/06

APPENDIX A

EXECUTED DECLARATION UNDER 37 C.F.R. § 1.131

INCLUDING EXHIBITS 1-4

P14979-A

Docket No. No. P14979-A
(YAM.046)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Yoshitaka FUJITA

Serial No.: 10/050,600 Group Art Unit: 2616

Filed: January 18, 2002 Examiner: Shand, Roberta A.

For: MULTIPLEXING METHOD AND APPARATUS, DEMULTIPLEXING METHOD AND APPARATUS, AND ACCESS NETWORK SYSTEM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

DECLARATION UNDER RULE 37 C.F.R. § 1.131

Sir:

I (Yoshitaka FUJITA), do hereby state that:

1) I am the sole inventor of the above-identified application.

2) The MULTIPLEXING METHOD AND APPARATUS, DEMULTIPLEXING METHOD AND APPARATUS, AND ACCESS NETWORK SYSTEM was known to me earlier than January 3, 2001, as shown in the enclosed "Dependent or Connected Invention Notification, Assignment, Argument (Extract)" (Exhibit 1) and English translation thereof (Exhibit 2), together with a Description of the Invention and Drawings (Exhibit 3), and English Translation thereof (Exhibit 4).

3) The effective date of the "Dependent or Connected Invention Notification, Assignment, Argument (Extract)" (Exhibits 1 and 2) and Description of the Invention and Drawings (Exhibits 3 and 4) are earlier than January 3, 2001 and the dates thereof have been redacted.

4) The "Dependent or Connected Invention Notification, Assignment, Argument (Extract)" (Exhibit 1) and Description of the Invention and Drawings (Exhibit 3) were forwarded to the Division Manager, Kou Murakami earlier than January 3, 2001 and the Division Manager, Kou Murakami's decision on the patentability of the invention was entered earlier than January 3, 2001; and the application and the executed formal papers were filed in the Japan Patent Office on January 22, 2001.

5) The contents of the enclosed "Dependent or Connected Invention Notification, Assignment, Argument (Extract)" (Exhibit 1) and Description of the Invention and Drawings (Exhibit 3) have been incorporated into the specification of the present invention, upon which claims 1-27 are based.

6) The above clearly evidences a completion of the invention (e.g., an actual reduction to practice) in the United States, a NAFTA or WTO member country before the filing date (e.g., January 3, 2001) of U.S. Patent Application Publication No. 2002/0085591A1 to Mesh. Therefore, the U.S. Patent Application Publication 2002/0085591A1 to Mesh is removed as prior art under 35 U.S.C. § 102(e).

7) In the alternative, I declare that the claimed invention was conceived prior to January 3, 2001 (e.g., as shown by the attached "Dependent or Connected Invention Notification, Assignment, Argument (Extract)" (Exhibit 1) and Description of the Invention and Drawings (Exhibit 3) having a date (now redacted) prior to January 3, 2001 and, coupled with due diligence from a date before January 3, 2001, until the invention was constructively reduced to practice on January 22, 2001. That is, the application and the executed formal papers for Japanese Application Serial No. JP 2001-012997, from which the present application claims foreign priority under 35 U.S.C. § 119, were filed in the Japan Patent Office on January 22, 2001.

8) The facts above in 6) clearly show a completion of the invention in a NAFTA or WTO member country before January 3, 2001. Alternatively, the facts in 7) above show a conception of the invention prior to January 3, 2001, and due diligence from just before January 3, 2001, until the filing date (i.e., the constructive reduction to practice) of the foreign priority application on January 22, 2001.

I hereby declare that all statements made here of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Further declarant sayeth not.

Date: August 3, 2006

Yoshio Fujita

Yoshitaka FUJITA

業務発明届出・譲渡・意見書

（ＮＥＣ単独出願）

【発明者記入欄】

[redacted]

仮番号	13261417
整理番号	492-20169

発明の名称　回線多重装置

発明者						
	確認	会社コード 社員番号	氏名 ローマ字（外国出願に用いるため）	電話　地区－番号 外線ダイヤルイン	Ｅメールアドレス 外線ＦＡＸ番号	会社名 所属部門名
1	済	0000 0603874	藤田 佳賢 FUJITA YOSHITAKA	22-71003 044(396)2103	fujita@ptl.tmg.nec.co.jp 044(435)5697	日本電気株式会社 ネットワークス開発研究所第二研究部

届出の形態	●発明説明書（実施の形態・図面等）による届出 ○明細書全文による届出 ○コンカレント	
外国出願	●希望する ○希望しない	出願希望国　アメリカ
国内優先権主張	○自発的 ○知的財産部の要請 ●希望しない	先の発明の出願番号 先の発明の出願日　　年 月 日（西暦８桁で記入のこと） 先の発明の整理番号　－ 知的財産部要請日　　年 月 日（西暦８桁で記入のこと）
社外発表出荷予定	○製品発表 ●論文発表 ○新聞発表 ○その他 ○社外発表なし	製品名 学会名　電子情報通信学会総合大会 発表予定日　2001年03月25日（西暦８桁で記入のこと）
	□製品出荷	製品出荷先 出荷予定日　年 月 日（西暦８桁で記入のこと）
関連発明（あれば入力）	出願番号 出願日　　年 月 日（西暦８桁で記入のこと） 整理番号　－ 外国出願してあればその国名	
発明の種類	●通常の発明である。 ○ビジネス方法（やり方や仕組み）に関する発明である。	

譲　渡

上記の発明について、日本電気株式会社従業員就業規則にもとづいて、 特許または実用新案登録を受ける権利を日本電気株式会社に譲渡いたします。

Exhibit 1
Serial No. 10/050,600　　Docket No.: P14979-A

【所属部長意見記入欄】

[redacted]

権利の帰属	発明をするに至った行為が現在または過去の職務に ●属する ○属しない
関連する プロジェクト	プロジェクトの名称　IPアクセス装置開発 ○重要開発プロジェクト　●左記以外のプロジェクト　○該当なし
特定得意先 との関係	□防衛庁　□ＮＴＴ　□通産省　□ＪＲ　□ＮＰ(National Project)

発　明　の　評　価

1. 登録の可能性
   ○８０％以上　●６０～８０％　○３０～６０％　○３０％以下　○可能性なし

2. アイデアの性質（複数選択可）
   □技術コンセプトが新しい　■このアイデアの実現が望まれる
   □今後重要になる技術の先取り　□新規機能を提供する　□優れた代替手段を提供する

3. 基本／改良
   ○全くの基本発明　●どちらかといえば基本発明
   ○本格的改良発明　○部分的改良発明

4. 技術的効果
   ○きわめて大　○大　●普通　○小

5. 実施見込み（社外を含む）
   ○実施決定　○試作中　○試作中（出荷予定なし）　●５年以内に実施の可能性あり　○不明
   年　月　日出荷予定（西暦８桁で記入すること）

6. 汎用性（他の技術領域に応用できる可能性）
   ○高い　●普通　○低い

7. 技術の寿命
   ○長い　●中程度　○３年以下

8. 回避の可能性
   ○不可能　○かなり困難　●可能性あり　○容易

9. 侵害の確認
   ●容易　○かなり困難　○きわめて困難

総合評価	○Ａ　●Ｂ１　○Ｂ２

外国出願	●する　○しない

出願国

A項の国の□部分をクリックし、選定理由としてB項の該当する数字を（　）内に入力する。 なお、4および5項の競争会社名も同じ（　）内に入力

A　国名		B　理由
■アメリカ	US（ 1 ）	1．この発明を実施した製品を輸出する見込みがある。
□韓国	KR（　）	2．この発明を実施した製品を現地生産する見込みがある。
□中国	CN（　）	3．この発明に関する技術を技術輸出する見込みがある。
□台湾	TW（　）	4．この発明に関係する機種につき当社がライセンスを受けている相手方が 企業活動をしている（会社名をA項の（　）内に記入）
□イギリス	GB（　）	
□ドイツ	DE（　）	5．この発明を実施した製品の分野で競争関係にある会社がある。（会社名をA項の（　）内に記入）
□フランス	FR（　）	
□イタリア	IT（　）	6．その他上記以外の理由があれば（　）に記入）
□スエーデン	SE（　）	
□オランダ	NL（　）	
□カナダ	CA（　）	
□オーストラリア	AU（　）	
□シンガポール	SG（　）	
□マレーシア	MY（　）	
□タイ	TH（　）	
□フィリピン	PH（　）	
□インドネシア	ID（　）	

所属部長決定	届出：本発明は特許性があると判断しますので出願を依頼します。 ●届出可 ○公開技報　○併合による中止 ○併合以外の理由による中止 所属部長　社員番号 0546616　氏　名：村上　紅

【選別責任者記入欄】

[redacted]

選別責任者入力欄	○S級とする ●届出可　○公開技報　○併合による中止　○併合以外の理由による中止 選別責任者（不在のときは発明者の所属部長）　社員番号 0546616　氏　名：村上　紅

【備考欄】

備　考	知的財産部への要望

Dependent or connected invention notification, assignment, argument (extract)

[Fields for the inventor to fill]

[redacted]

Provisional number	13261417	Title of the Invention: Circuit Multiplexer
Reference number	492-20169	

Inventor						
	*	Company code, staff number	Name: *	*	*	Company name, division name
1	*	0000 0603874	FUJITA YOSHITAKA	*	*	NEC corporation Networks research & development, second laboratory

Notification form	Notification by description of the invention (Embodiments, Drawings, and the like) * *	
Foreign application	Want to apply *	Country to be applied: the United States of America
Domestic priority claim	* * Not want to claim	* * * *
Release to the outside and shipment schedule	* Release by article * * *	* Academy name: The Institute of Electronics, Information and Communication Engineers, general assembly Scheduled date of release: 2001, March 25th
	*	* *
*	* * * * *	
Type of invention	General invention *	

Assignment

For the above invention, I will assign a right to be patented or registered for utility model to the NEC corporation, based on the employment regulations of the NEC corporation.

[Fields for division manager to fill in opinion]

[redacted]

Belongingness of right	Experiments that lead the inventor to the invention Belongs to the current or past service. *
Related projects	Project name: Development of IP access device
	Important development projects other than *
*	*
*	

1. Possibility to be registered
* 60-80% * * *
2. Quality of idea
* This technique is desired to be realized
* * *
3. Basic/improvement
* Sort of basic invention
* *
4. Technical advantage
* * Moderate *
5. Possibility to be implemented
* * * Possible to be implemented in five years *
*
6. Versatility
* Moderate *
7. Life of technique
* Moderate *
8. Possibility to be avoided
* * Possible *
9. Recognition of invasion
Easy * *

Comprehensive evaluation	* B1 *

Foreign application	Apply *		
*	*		
	A Country		B Reason
	the United States of America *	1 *	1. Products implementing the invention are likely to be exported.
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	*	*	
	*		
Division manager's decision	I evaluate that this invention has patentability. File this invention. *		
	Division manager	Staff number 0546616	Name: KOU MURAKAMI

[Fields for person in charge of selection to fill]

[redacted]

Fields for person in charge of selection to enter	* Can be notified	*	*	*
	Person in charge of selection	Staff number 0546616	Name: KOU MURAKAMI	

[*]

*	*

【発明の名称】

回線多重装置

Exhibit 3
Serial No. 10/050,600 Docket No.: P14979-A

【発明の特徴】

図１はアクセスネットワークシステム全体構成を示している。本発明の特徴は各加入者（端末）がインターネットに接続しようとするシステムにおいてPC（101: Personal Computer）からのインターネットアクセス要求に対しIP（Internet Protocol)パケットデータを運ぶ為のPPP（ Point-to-Point Protocol）パケットデータ（図8、図9-1～-3、及び【発明の背景】の項参照)をEthernetフレーム（またはIEEE 802.3のフレーム、詳細図13参照、以降Ethernet/802.3と略）に乗せ(RFC 2516参照）、加入者としてのATU-Rにおいて本フレームそのものを図中のADSL(Asynmetric Digital Subscriber Line)/VDSL(Very high speed Digital Subscriber Line)インタフェースを通ることができるようにアナログ変調をかけて加入者多重化装置DSLAM（Digital Subscriber Line Access Multiplexer）まで運びDSLAMからEthernet/802.3フレームをもつPHYインタフェースを通してAG（Access Gateway)装置まで運ぶ事を特徴としている。また本発明の方式はPPPパケットデータについての全てのパケット（制御用及びIPパケットデータ用、図9-1 Protocol Field参照）に適用される。PPP（RFC 1161参照）とは認証(Aucentication→登録されていない加入者はLinkそのものが張れずデータの転送が出来ない、またIPアドレスそのものの配布が受けられない）、課金(Accounting→接続している時間）、サービスそのものの管理（SMS: Service Management System)、加入者ごと（この場合はATU-R)の帯域の割り当て及びQoSの確保等々を行うものである。具体的にPPPそのものはISP（Internet Service Provider)の入り口に配備されISPにより前記した認証、課金、サービス管理、加入者ごとの帯域の割り当て等々（QoSの保証）を行うためのものである。

図15に示されるように従来ATMセルをベースとして処理するDSLAMにより加入者（ATU-R）からのIPデータ（信号上り方向）はAAL5（ATM Adaptation Layer 5）化されたATMセル信号（ATMセルヘッダVPI/VCIは加入者ごとに異なる)となりさらにADSL/VDSLインタフェースを通ることができるようにアナログ変調をかけてDSLAMまで運びDSLAMにおいて元のデジタルのパケット信号に戻されて多重化された後ATM SW（ブロック601）にて他のDSLAMからの同様な信号がさらに多重化されインターネットのバックボーンネットワークに入る直前に終端専用の別装置を設置(図15、ブロック701）することで本プロトコル（PPP）を終端していた。この際DSLAMにおいて加入者（ATU-R）の識別そのものはユニークに割り振られたVPI/VCIで行われバックボーンネットワークあるいはPPP終端用装置から来る信号（信号下り方向）はVPI/VCIで分離され各加入者に運ばれていた。

本発明によれば信号上り方向（端末：PCからAG：Access Gatewayへ向かう方向）において端末であるPCからのパケット信号(IPデータ)はATU-RにおいてPPPヘッダ（図8参照）が付加（Encapsulation)されさらにEthernet/802.3のフレームヘッダ（MACアドレスは加入者ごとに異なる、図8参照のこと）が付加されてADSL/VDSL信号に変換されてDSLAMまで運ばれる。DSLAMにおいてそれぞれのパケット信号はブロック202（図2）において先のMACアドレス（この場合は各加入者のMACアドレスはSource MACアドレスとなる、MACアドレス詳細は図4参照のこと）を先頭にFIFO Queuing 202-1～N（図6-2参照）に書きこまれに多重される。多重された信号はPHYレイヤー処理を行うブロック204（図6-1）においてEthernet/802.3信号に変換され信号2101として装置より出力される。そして次の装置であるAG（Access Gateway)でPPPプロトコル信号としての処理（図9-2、9-3参照）がなされる。逆に信号下り方向（AGから端末：PCへ向かう方向）においてDSLAMでは図5-1、-2に示されるようにPHYレイヤー処理を行うブロック206からの信号は先の加入者ごとに割り振られたMACアドレス（この場合はDestination MACアドレス、図8参照）により各パケットは多重分離される。多重分離された各パケットはFIFO 203-2.1～203-2.N（図5-2）に書きこまれ読み出された後PHYレイヤー処理を行うブロック207からVDSL/ADSL信号に変換されて出力される。

本発明はDSLAMにおいて固定長であるパケットのATMセルとしての技術を用いずに可変長パケットのEthernetパケット信号を用いることで加入者からのデータの多重化あるいは多重分離化を行い、同様にAGにおいてMACアドレスによって各加入者（この場合はATU-R）を判別する事によりPPPによって定められた加入者ごとの割り当てた帯域の確保やQueuing等々の制御を行う事によりアクセスネットワークシステム全体において課金、認証のみならず各加入者のQoSを保証する事を特徴とする。

【発明の実施例】

図１は本発明を含むアクセスネットワークシステム全体の構成を示している。　本図において端末(101: PC)よりバックボーンネットワーク方向（信号上り方向）に出力されるIPパケットデータ（図14参照）はATU-R（102）でPPP Encapsulation（図8参照）がなされEthernet/802.3としてのフレーム（詳細MACアドレスについては図4参照のこと）が付加されさらにアナログ変調されてメタリックケーブル上のADSL/VDSLインタフェースを通して可変長パケットを処理の基本とする（パケットベース）DSLAM装置(201)まで運ばれる。DSLAM装置(201)において多くの加入者(102: ATU-R)からのパケット信号が加入者ごとに割り振られたMACアドレス（この場合はSource MACアドレス）を用いて多重され約100Mb/sのEthernet/802.3フレームを持った信号(2101)として出力される。 AG（301)においてそれらパケット信号はPPPとしての制御処理に関するパケットのみ（図9-1、Protocol Field 8021/c021）についてCPU盤（図2、ブロック308参照）にて処理（内容は発明の背景参照）がなされ、それ以外のデータとしてのIPパケット（図3、3101）は一旦PPP Encapsulationヘッダが取り除かれPOSインタフェース（Packet Over Sonet/SDH、詳細フレームフォーマットは図12参照）を通してバックボーンネットワークへと転送される（この場合も先と同様IPパケットをPPP Encapsulationする事は必要であるが前述した加入者からのPPP処理とは異なる、第二の実施例にて詳述する、Encapsulationはインタフェースブロック304にて行われる）。また本AGにおいて各加入者に対しての前記した認証、課金等々の制御（発明の背景参照）が行われる事になる。 逆にバックボーンネットワークからの信号下り方向においてPOSインタフェースによるIPデータの転送の為PPP Encapsulationされたパケットデータ（3102）はインタフェースブロック（306）にてPPPヘッダが取り除かれPPP 処理(POS用のプロトコル処理：対向装置との間でやり取りされる最大パケット長:Maximum Transfer Unitサイズの決定等）が施された後、約100Mb/sのEthernet/802.3フレームを持った信号(2102)として出力される。 DSLAM装置（201)ではそのEthernet/802.3フレームを持った信号(2102)はMACヘッダ情報（Destination MAC Address、図8参照のこと)により目的とする加入者を判別する事ができ、本情報（Destination MAC Address）により多重分離されADSL/VDSLインタフェース(1102）を通して各加入者(102：ATU-R）に運ばれる。ATU-R（102）では前述した受信信号よりヘッダ情報としてのEthernet/802.3及びPPPヘッダが取り除かれもとのIPパケットとしてPC（101）へと入力される（図中示されているようにATU-R～PC間においてEthernetインタフェースが用いられる場合はEthernet/802.3パケット中のSo

urce/DestinationのMACアドレスが存在するが通常のLANと同様な為ここではあえて記載しない）。

図2にAGについての装置内ブロック図が示されておりAGの動作について説明する。DSLAM装置よりEthernet/802.3インタフェース（2102）を通し入力されるパケット信号(フォーマットは図8参照）はPHYブロックである307で受信し本ブロックにおいてSource MACアドレス（これによりどの加入者ATU-Rより来たパケットかが分かる）によりパケットスイッチモジュール（図2、3、ブロック302）にてEthernet/802.3パケットフレームを単位としてスイッチングがなされCPU盤(図2、3、ブロック308）あるいはPOSインタフェース(304)へと出力される。 インタフェースブロック305においてEthernet/802.3パケットフレーム中のProtocol Field値(図9-1参照）を参照する事によりIPパケットデータ(値: 0021)かLinkコントロール用制御パケット(値: 8021又はc021）かの判別がなされる。

IPパケットデータであった場合そのパケットはPPPのヘッダ部分（図8のFlag/Address/Control/Protocol/FCS/Flagのパケットデータ以外の部分）が取り除かれ(PPPが終端を意味）パケットスイッチモジュール(302）に転送されスイッチされて出力インタフェースブロック(304)を通しバックボーンネットワーク(図3、信号3101：信号フォーマットは図12）へと出力される。 逆にバックボーンネットワークより入力される信号方向（下り方向）においてバックボーンネットワークからのPOS信号(3102)にマッピングされたパケットデータは入力インタフェースブロック(306）において加入者へ向けてのPPP処理の為のProtocol Field値:0021（図8、図9-1参照）が付加されPPPパケットとして再びパケットスイッチ盤(302)に転送されパケットスイッチされた後PHYブロックである307でMACアドレス（この場合各加入者のMACアドレス）が付加されEthernet/802.3フレームとしてDSLAM装置(図1、201）に出力されその中で各加入者としてのMACアドレスにより多重分離された後各加入者(102：ATU-R）へと転送される。

次にPPPの終端について説明する。図2を参照すればわかるようにDSLAM側より入力されるPPPパケットがLinkコントロール用パケット(Protocol Field値: 8021/c021）の場合そのパケットはパケットスイッチモジュール(302)においてスイッチされCPU盤（308）へと転送される。CPU盤(308)では受信したPPPパケットに対しプログラム制御によりそのプロトコル終端（図9-2、9-3参照）を行うべく各加入者（ATU-R）へ向けPPPパケット送出が行われる。そのCPU盤(308)からのPPPパケットはパケットスイッチモジュール（302）に転送されPHYインタフェースブロック(307）を通しDSLAM装置に出力され通常のデータパケットと同様にMACアドレス（この場合は各ATU-RのMACアドレスがDestination MACアドレスとなる）により多重分離されて各ユーザー(ATU-R）へと転送され加入者とAGの間においてPPP処理が行われる。

【実施例の構成】【実施例の動作の説明】

図2及び3に本発明におけるAG（Access Gateway)、及びDSLAM装置についての装置内詳細ブロック図が示されている。本詳細ブロック図2、3を参照し以下にそれら各構成の詳細な動作を示す。

まずDSLAM装置はバックボーン側と信号入出力を行うEthernet/802.3インタフェースブロック（204/206）、加入者側との信号入出力を行うADSL/VDSLインタフェースブロック（205/207）、MACアドレスに元つきバックボーンより入力されたEthernet/802.3パケットを各加入者に割り振る為の多重分離化ブロック203、各加入者側から入力されたEthernet/802.3フレームを持つパケットを多重化するブロック202等々からなる。

図5-1、-2においてはバックボーン側より来る（信号下り方向）Ethernet/802.3フレームを持つパケットが多重分離される様子が描かれている。まずバックボーン側から来るパケット信号2102（フレームフォーマットは図8参照）はPHYブロックである206にて受信がなされる。206よりパケット信号2102-2（信号フォーマットは同じ）として出力され本パケットはATU-RへのDestination MACアドレスにより各加入者が判別されフィルタリングブロック203-1（図5-2）においてパケットの先頭のDestination MACアドレスを検出する事により多重分離がなされる。

ここでMACアドレスの設定について図4を利用して説明する。 本図を見れば分かるようにAGからの信号2102はDestination/Source MACアドレスとして2011/3011（2011はDSLAMにおいての各ATU-Rへ向かうポートのアドレスで3011はAGにおいての各DSLAMへ向かうポートのアドレス）あるいは1021/3011（1021は各ATU-Rについてのアドレスで3011はAGにおいての各DSLAMへ向かうポートのアドレス）を持ちFiltering Block 203-1に入力される。ここでDSLAMの加入者への各ポート（ADSL/VDSLインタフェース）はATU-Rに1対1にて接続されているのでDestinationアドレスとしては2011、1021のどちらでも良くDSLAM内にて加入者が特定されるので振り分けることはできる。 図5-2においてMACアドレスとして2011/3011を持つパケットがブロック203-1に入力されたた信号はFilteringによりFIFO203-2.1に書き込まれる。 この際 図14によれば入力パケット(2102-2)のIPパケット中の先頭より3～4バイト目のLengthフィールドを参照する事により本パケットが全体で何バイトあるか知る事ができるのでそのバイト数分FIFOに書き込めば良いことになる。また本FIFOは前述したように最長のパケット分の容量が確保されておりAGにおけるシェーピング機能（詳細後述する）により本到着パケット以前のパケットの残留はなく常に最長の1パケット分書き込める状態にある。FIFO 203-2.1への書き込みが完了したパケットは直ちに読み出し動作に入りADSL/VDSLとしてのインタフェース速度（例えば6M b/s程度）にてブロック207からパケット信号1102として出力される。 この場合のMACアドレスはブロック207において全て1021/2011（前述したDestination/Source MACアドレスとして2011/3011あるいは1021/3011のパケット全てについて）として付け替える事が必要となるが合計でN個の加入者に対し1対1にて接続されている為にATU-Rは受信したパケットは全て自身宛として処理される事になる。つまりADSL/VDSL インタフェースPHYブロックである207及び205は各加入者ごとに対応してあり本図においては205はATU-R102に対応している。また他のポートについても同様にパケットが処理される。

図6-1、-2においては加入者側より来る（信号上り方向）Ethernetフレームを持つパケットが多重される様子が描かれている。ADSL/VDSLインタフェースを通して加入者側から来るパケット信号1101（フレームフォーマットは上り方向と同じく図8参照）はPHYブロックである205にて受信がなされる。 図6-2において加入者（ATU-R 102）より205に入力されたパケット信号1101は一旦FIFO 202-1（FIFO数は加入者ライン数と同じN個ある、またFIFO容量については後述）に書き込まれる。本図において信号下り方向と同様に入力パケット(1101)のIPパケット中の先頭より3～4バイト目のLengthフィールド（図14参照）を参照する事により本パケットが全体で何バイトあるか知る事ができるのでそのバイト数分FIFOに書き込めば良いことになる。 それぞれのパケットがFIFOに書き込まれた後各FIFO（202-2から202-Nまで）より順にパケットを読み出す事で多重化を行う事ができる。 この場合信号下り方向と同様に加入者ごとに割り振られたMACアドレスにより各加入者が判別されることになる。この場合（信号上り方向）についてのMACアドレスの設定について信号下り方向と同様に図4を利用して説明する。 図4を見れば分かるように加入者（ATU-R 102）からの信号1101はDestination/Source MACアドレスとして2011/1021（1021

はATU-R 102のアドレスで2011はDSLAMにおける該ポートのアドレス）を持ちFIFO Queuing Block 202-1に入力される。　他の加入者（ATU-R 112～）からのパケット信号（1103～110N）についても同様にそれぞれFIFO Queuing Block 202-2～-Nへ入力される。　多重されたあとのパケットは加入者を識別する為にSource MACアドレスとして2011あるいは1021の付加されたものがそのまま多重されDSLAMよりEthernet/802.3フレームを持つパケット2101信号として出力される。

QoSの保証について、ここで言うQoSとは加入者ごとに設定された帯域が確保され、パケット落ちが無く、信号伝送における遅延が最小である事を意味する。　帯域の設定やトラヒックのシェーピング等は従来からあるATM SWのようにAG（Access Gateway)において各フロー（例えば目的とするMACアドレスへ向けてのパケットデータ)について行われるものとする。　例えばトラヒックシェーピングや遅延について図7-1を利用して説明する。AGにおいて各パケットを処理するパケットスイッチモジュール(302)内は入力されるフローが全てメモリに格納されそのメモリは図7-1のように細かくQueuingがなされている。　例えば信号下り方向であるDSLAMへ向かうポート(307）は各加入者ごとに（302)内にてQueuingがなされる。各Queueは優先順位（302-1.1、302-1.2、302-1.3、、、）が付けられ例えば一つの加入者であるATU-R 102へ向けてのパケット信号は302-1.1にQueuingがされるので他のパケット信号よりも優先的に処理がなされ遅延も最小でポート(307）で出力される。　また確保すべき帯域が6M b/sの場合、最大帯域が6M b/sとなるべくラヒックシェーピングがなされる。AGの出力ポート(307)より出力されたパケット信号はDSLAMにおいてのフィルタリングブロック203-1においてパケットの先頭のMACアドレスを検出する事により多重分離がなされ、分離がなされたパケット信号2102-3（図5-2参照）はFIFO203-2.1に書き込まれる。　この際 各加入者ごとのADSL/VDSL インタフェースのスループットは6M b/sとすると、FIFO203-2.1には常に6M b/sの速度でパケットが書き込まれ6M b/sの速度で読み出されるのでQoSが満たされる為には各FIFOにつき1パケットの最長パケット長バイト分のFIFOメモリが必要となる。しかしパケット長が長くなり本FIFO203-2.1の容量を越えたとしてもAGにおけるシェーピング機能により本パケットはフラグメント化（細分化）され本FIFOからあふれ出てしまう事は無い。

逆に信号上り方向において各加入者（例えばATU-R 102）からのパケットデータはADSL/VDSL インタフェースの場合スループットは低く数100k b/sのオーダーであるがたとえ数100k b/sでもパケットが読み出されなければDSLAM内のFIFO202-1に詰まってしまいデータが壊れてしまう。そこで図6-2の各FIFO202-1～-Nは1パケットの最長パケット長バイト分の容量を有しており各FIFOからはEthernetインタフェースブロック204へ約100Mb/sのスループットにて読み出されEthernet/IEEE802.3フレームを持った信号(2101)として出力される。ここで1つの加入者であるATU-R 102からの信号のみについて説明したが合計でN個の加入者（ATU-R 1N2がある事を想定している）。またEthernet/IEEE802.3フレームを持った信号(2101)への変換はPHYブロック(204）においてなされる。AGに到着した各パケットは信号下り方向にて説明した内容と同様、各パケットを処理するパケットスイッチモジュール(302)内は図7-2のようにフローごとに格納される為細かくQueuingがなされている。　DSLAMから来る上りパケット信号は各加入者ごとに（302)内にてQueuingがなされ、各Queueは優先順位（302-2.1、302-2.2、302-2.3、、、）が付けられ例えば一つの加入者であるATU-R 102からのパケット信号は302-2.1にQueuingがされるので他のパケット信号よりも優先的に処理がなされ遅延も最小でAGよりバックボーンネットワークあるいはCPU盤へ出力される。この場合は上り信号の速度がたかだか数100k b/sのオーダーであるが、下り同様確保すべき帯域が6M b/sの場合としそのようにトラヒックシェーピングがなされる。

次にAGにおいてのPPPパケットの処理（図2、3参照）を例に取り詳細動作について説明する。図2に示されているようにAG（301)においてそれらパケット信号はPPPとしての制御処理に関するパケットのみ（図9-1、Protocol Field 8021、c021）についてCPU盤（図2、ブロック308参照）にて処理がなされ、それ以外のデータとしてのIPパケット（図3、3101）はPOS（OC-12c）インタフェースブロック（304）において一旦各IPデータに対し各加入者ATU-Rとの間で使用されているPPP Encapsulationヘッダは取り除かれPOS用の新たなPPP Encapsulation（フォーマットそのものは同じであるが相手側のPOSインターフェースとの間で最大転送パケット長：MTUサイズ等の情報をやりとりする）がなされ本POSインタフェースを通してバックボーンネットワークへと転送される。　CPU盤におけるPPPとしての制御処理に関するパケットの（図9-1、Protocol Field 8021、c021）処理についてCPU盤（図2、ブロック308）はProtocol Field 8021、c021を持つPPPパケットが加入者から来た場合、図9-2、-3についての処理（Link Control Protocol、やNetwork Control Protocol）を行う為に図2に示されているようにCPU盤(308)と各ATU-Rの間で制御パケットの転送を行う。Linkの確立に必要なプロトコルのやり取りが終わると図3に示されるように実際のバックボーンネットワーク（インターネット）との間でIPパケットデータのやり取りを各加入者（ATU-R）は行いインターネットにアクセスする。

また前述したPPPパケットの制御情報の交換を行う事により本AGにおいて各加入者に対しての前記した認証、課金等々の制御が行われる事になる。　バックボーンネットワークと本AG間の各パケット信号（図1、3101/3102）はPOSによるIPデータの転送の為PPP Encapsulation（前述した加入者からのPPP処理とは異なる、図11、12参照）についてインタフェースブロック（304/306）にてPPPヘッダの付加あるいは削除が行われる。前述してきたようにPOSにおけるPPP処理の後約100Mb/sのEthernet/802.3フレームを持った信号(2102)としてあらたにPPP 処理(プロトコル処理とEncapsulation）が施され入出力される。

【効果の説明】

以上説明したように本発明は、図１に示されるようなシステムにおいてAG（Access Gateway）としての機能と従来ATMベースで実現していたDSLAMの機能をパケットベースの処理で実現（加入者の判別含み）する事により加入者からのPPPパケット信号（認証、課金等々の制御を行う）を効率的に処理する事により、またATMセルアセンブリ/ディスアセンブリ機能であるAAL5を使わずにシンプル且つ安価な装置構成で各加入者のQoS確保を行う事ができるという効果を有する。

【発明の他の実施例】

図10は第二の実施例として本発明を含むアクセスネットワークシステム全体の構成を示している。　第一の実施例と異なる所はDSLAM～AG間をEthernet/802.3インタフェース(2101/2102）にて構成していたのを伝送距離を伸ばす為にPOS Frameを持った光信号（OC-3c）とした点である。アクセスネットワークシステムとしての動作は第一の実施例とほぼ同様である。但しDSLAM～AG間をPOS Frameを持った光信号（OC-3c、図12参照）とする場合、前述してきたようなMTUサイズを決める為のPPP処理がなされその間で伝送されるパケットをPPP Encapsulationする必

要がある。　またもともと各加入者であるATU-Rからの信号はPPP EncapsulationされているのでそのまPPP パケットがさらにPPP Encapsulationされることになる（図11参照）。以下に基本的な動作について図10を用いて説明する。　端末(101: PC)よりバックボーンネットワーク方向に出力されるIPパケットデータはATU-R（102）でそのままメタリックケーブル上のADSL/VDSLインタフェースを通してパケットをそのまま多重化しPOS（Packet Over SONET)インタフェースを持ったOC-3c信号として出力、あるいはPOS OC-3c信号としてパケットベースの多重分離を行うDSLAM装置(201)まで運ばれる。　パケットベースのDSLAM装置(201)において多くの加入者(102: ATU-R)からの信号が多重され155Mb/sのPOS Frameを持ったOC-3c信号(2101)として出力される。

本第二の実施例としてのAG（301)において入力されるパケット信号(2101)は加入者との間でのPPP制御処理に関するパケット(図2参照）のみをパケットスイッチモジュール(302）を通してCPU盤（308）へ出力し、CPU盤が各ATU-Rとパケットのやり取りを行う事でPPP処理を行う。ここでのPPP処理（PPP１とする）とはAG内のCPU盤とATU-Rの間のやり取りの事でDSLAM～AG間のPPP処理（PPP２とする）とは異なる。PPP２としての処理はDSLAM～AG間をPOSインタフェースにより接続した場合必要になるプロトコルでありPPPリンク処理や処理シーケンスそのものは図9-2のとおりである。　またPPP２はDSLAM～AG間をPOSインタフェースにより接続した場合必要になり図2におけるPOSインタフェースブロック307～206間及び305～204間において終端される。　本ブロックにおいて図11における最初のPPP Encapsuationは取り除かれ次のブロックへとパケット（PPP１のEncapsulationを持つ）運ばれる。　PPP２は　前述したような加入者の管理・制御（認証、課金、サービス管理、加入者ごとの帯域の割り当て等々）を行うのではなくAG～DSLAM間のPOSインタフェース間において転送される最大パケット長（Maximum Transfer Unit:MTUサイズ）の設定を行う。　またPPP１についてはAG内において第一の実施例に示されたのと同様に行われる。
　パケットベースのDSLAMにおいて第一の実施例ではMACアドレスが加入者判別のために用いられていたが図11に示されるように第二の実施例ではそれがないために判別する事ができない。そこでPOSインタフェース（2101/2102）を通してバックボーン側より来る（信号下り方向）PPPパケットをATU-RへのDestination MACアドレスの代りに各加入者（ATU-R）へ向け多重分離する為に各加入者に割り振られたIPアドレス（Filtering Blockフィルタリングブロック203-1（図5-2）参照、PPPパケット中のIPパケット先頭より17～20バイト目を見る事により用意に得られる）を用いて分離する。その他の多重分離の為の動作は第一の実施例と同じである。　つまりDSLAM内にて加入者が特定されるのでDSLAMの加入者への各ポート（ATU-Rに1対１にて接続されたADSL/VDSLインタフェース）はMACのDestinationアドレスとしては何でも良いが第一の実施例のようにあらかじめ割り振られているものを使用することを想定している。

本第二の実施例において信号上り方向における加入者側より来るEthernetフレームを持つパケットが多重される様子についても第一の実施例と同様である。つまりADSL/VDSLインタフェースを通して加入者側から来るパケット信号1101はPHYブロックである205にて受信がなされる。それぞれのパケットは加入者固有のIPアドレスを持ち、ブロック205にてEthernet/802.3フレームは取り除かれ多重される。またブロック204からはPOSインタフェースとして出力されるので図11に示されるようにこれらPPPパケットはPOSインタフェースを通して出力される為のPPP Encapsulationが再びなされる。

【発明の背景】

本発明が関するPPP（ポイントツーポイントプロトコル）の終端方法及び加入者からネットワーク（インターネット）への信号の多重化についての背景を説明する。前述（【発明の特徴】）してきたようにIPパケット転送の為ISPの入り口において通常PPPの終端が行われている。ここでPPPの終端そのものは従来より専用の機器を設置する事で対応してきた（図15参照）。　まず最初にインターネットに接続しようとする際、PPPはIPパケットを送出する際に確立しておかなければならないリンクプロトコルでありIPレイヤーの下に位置する（図9-1～-3参照）。HDLC形式のPPP Frameフォーマットは図8の通りでそのペイロードにおいて32BitsのProtocolフィールドを付加した後パケットデータとしてIPパケットが挿入される。リンク確立の為のプロトコルそのものは複雑ではない（図9-2、-3参照）が従来AAL5用いたATMセルにてPPP EncapsulationされたPPPフレームが送出されている為、PPPを終端する為にはまずAAL5のSARの処理が必要となる。SAR機能によりもとのPPPフレームが組みたてられCPUによりリンク確立の為の処理が行われる。リンク確立後に加入者はIPパケットをネットワーク（インターネット）に転送する事が出来る。このようにインターネットにアクセスしようとする各加入者を選別し本プロトコルの処理の為の機能を搭載した装置(図15、 701)をバックボーンネットワーク（インターネット）の入り口に設置していた。基本的にはIPパケットをATMセルへマッピングして情報の伝達が行われていた為に加入者のQoS確保を行う為にシステム全体として複雑で高価であった。　また本装置(図15、701)の設置場所は数多くの加入者が多重化されてくるバックボーンネットワーク（インターネット）の近くである事も多かった。

本発明の主な目的はインターネットアクセスする加入者が増えて行くにつれ本機能を持った装置を増設していく際、加入者により近い所つまりインターネットサービスを提供する装置内（図1、 301）に持つ事で加入者個々のQoSを確保しATMレイヤーを使うことなく加入者からのEthernet/802.3パケットデータをそのままVDSLやADSL等のインタフェースを通しAAL5によるパケットデータのセグメンテーションを行わずよりシンプルな装置構成で且つ加入者の増加に柔軟に対応していく事を可能とするものである。

以下にPPP終端処理の意味についてまとめる

インターネットに接続しようとする加入者の管理、つまりPPPの終端点がインター

ネットorプロバイダ(ISP）への入り口

具体的には

-認証(Aucentication）→登録されていない加入者はLinkそのものが張れずデータ

の転送が出来ない、またIPアドレスの配布が受けられない

-課金(Accounting）→接続している時間

そしてサービスそのものの管理（SMS)を行う

-加入者ごとの帯域の割り当て、及び最小遅延（QoSの確保）

PPPはpeer-to-peerの回線上でマルチプロトコルのデータ転送をサポートするプロトコルである。図8に示したのがPPP Frameフォーマットとしての HDLC-likeのフレーム構造である。

PPPの処理においてはLinkの確立（この後ユーザーとしての認証が行われる）が必須である。図9-1に示されているようにLCPパケット（Protocol Fieldの値で区別）によりLinkを確立し、次いでNCPパケット(Network Control Protocol)による上位層のデータ転送の為のConfigurationを行う。この後ユーザーパケットデータが転送される。

※出展IETF Document RFC1161/1162/1332/2516、IEEE 802.3

【権利範囲】

図1におけるパケット処理ベースのDSLAMにおいてのMACアドレスによる加入者（ATU-R）からのパケット多重及び多重分離方法。図10第二の実施例におけるPOSインタフェースを持ったパケット処理ベースのDSLAMにおいてのIP⇔MACアドレス変換による加入者（ATU-R）からのパケット多重及び多重分離方法、またPOSインタフェースに入出力させる為加入者からPPP Encapsulationされたパケットのさらなる PPP Encapsulation方法。AGにおけるそれらPPPパケットによる加入者の認証、課金及びQoSの確保等々の制御方法。パケットベースDSLAM及びAGとしての内部構成及び具体的方式。

【届出前自主サーチにおける検索式】

『PPP』＋『認証』＋『課金』＋『QoS』＋『Packet Over Sonet』＋『MACアドレス』＋『多重化』＋『多重分離化』＋『ADSL』＋『VDSL』＋『ISP』＋『DSLAM』＋『インターネット』＋『アクセスゲートウェイ』

【本発明に関連すると思われる公報の公開、公告または特許番号】

プロトコル終端装置(特願2000-252443、日本電気株式会社、 藤田 佳賢)

【サーチのためのキーワード】

『PPP』＋『認証』＋『課金』＋『QoS』＋『Packet Over Sonet』＋『MACアドレス』＋『多重化』＋『多重分離化』＋『ADSL』＋『VDSL』＋『ISP』＋『DSLAM』＋『インターネット』＋『アクセスゲートウェイ』

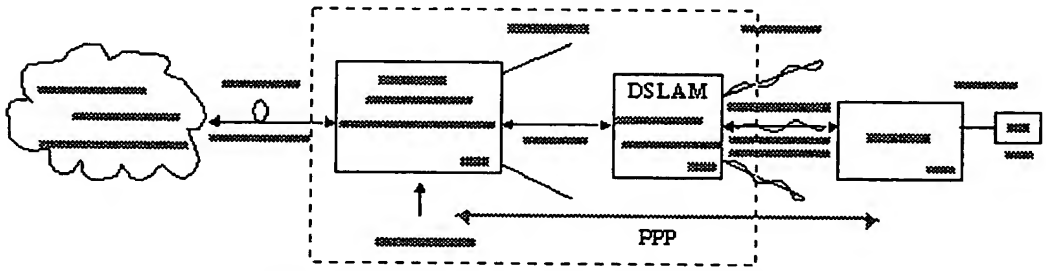

図1 アクセスネットワークシステム全体構成

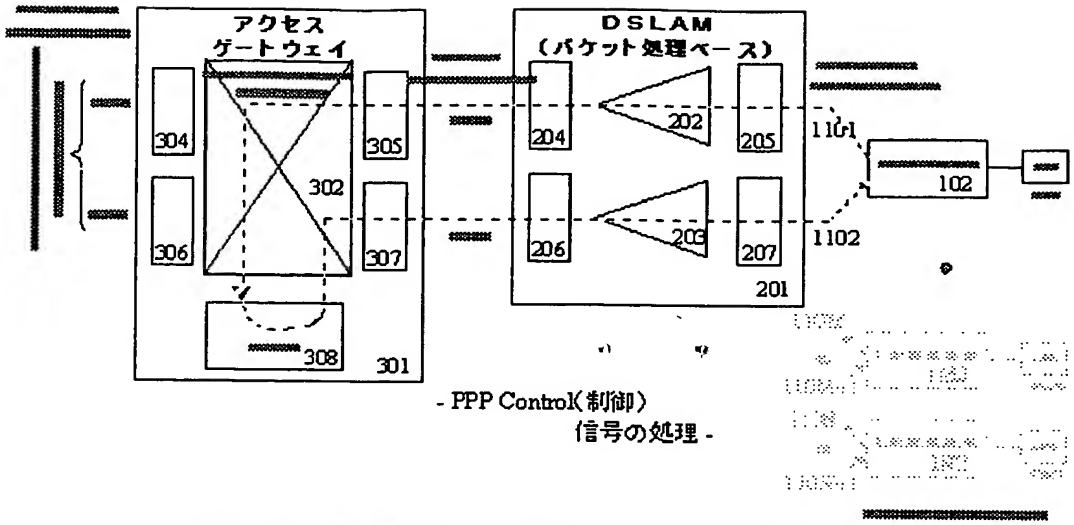

図 2 AG(Access Gateway)～DSLAM～ATU-R 処理ブロック

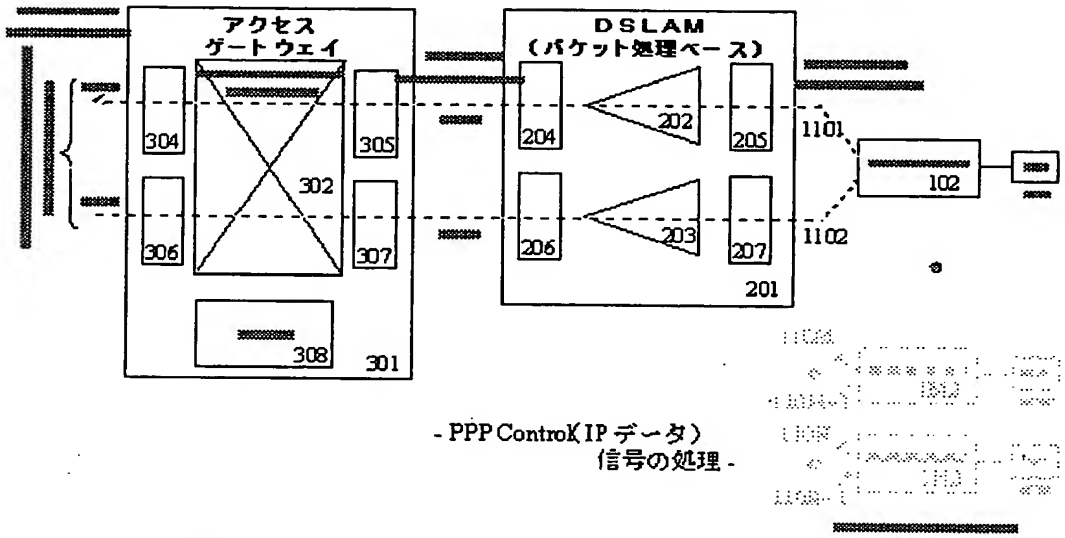

図 3 AG(Access Gateway)～DSLAM～ATU-R 処理ブロック

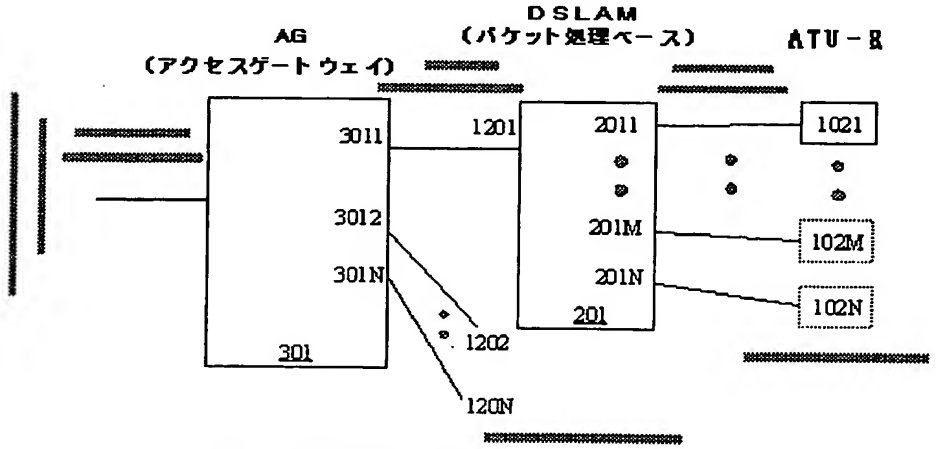

図 4 各装置に割り振られた MAC アドレス

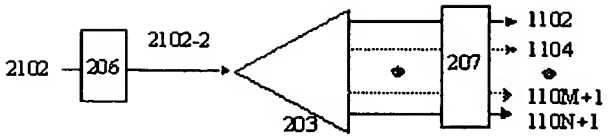

図 5-1 203 Block の詳細機能について

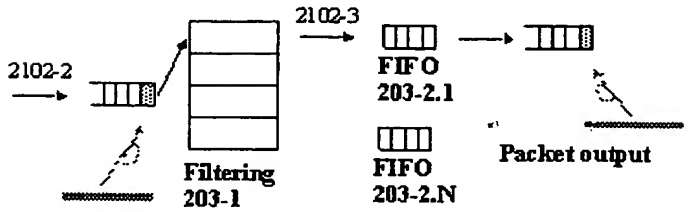

図 5-2 MAC アドレスによる加入者判別

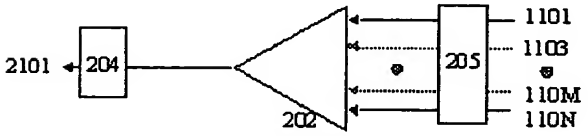

図 6-1 202 Block の詳細機能について

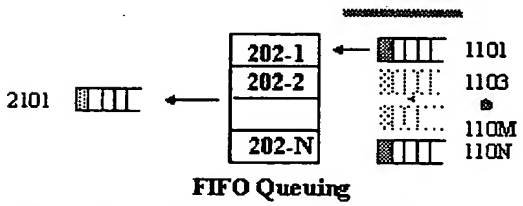

図 6-2 MACアドレスによる加入者からのパケット多重

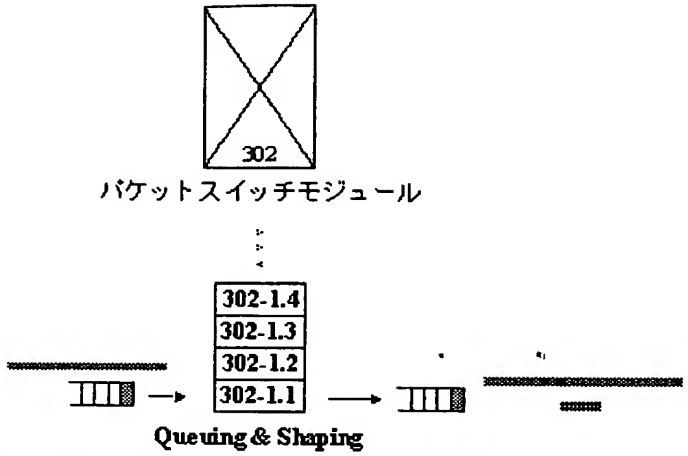

図 7-1 パケットスイッチモジュール (302) 詳細について

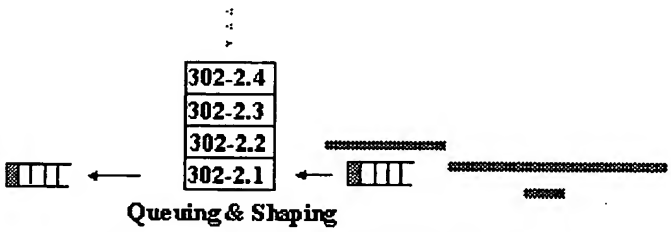

図 7-2 パケットスイッチモジュール (302) 詳細について

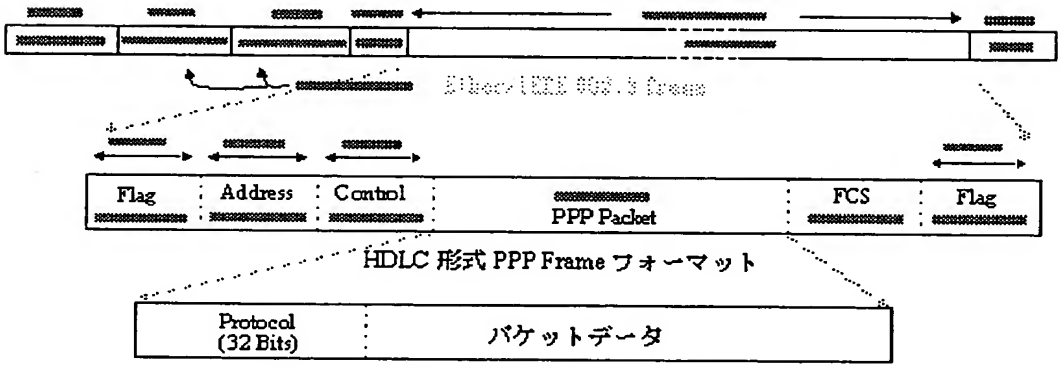

図 8 PPP パケットフォーマット

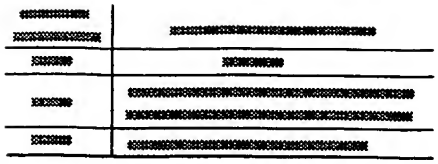

図 9-1 Protocol Field 値とパケットデータとの対応

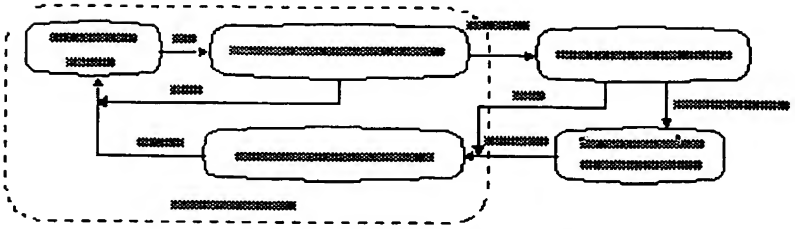

図 9-2 PPP Link 処理

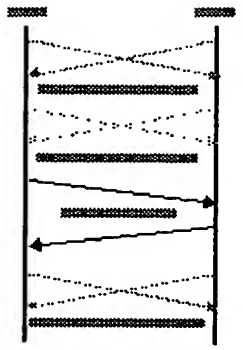

図 9-3 PPP 処理シーケンス

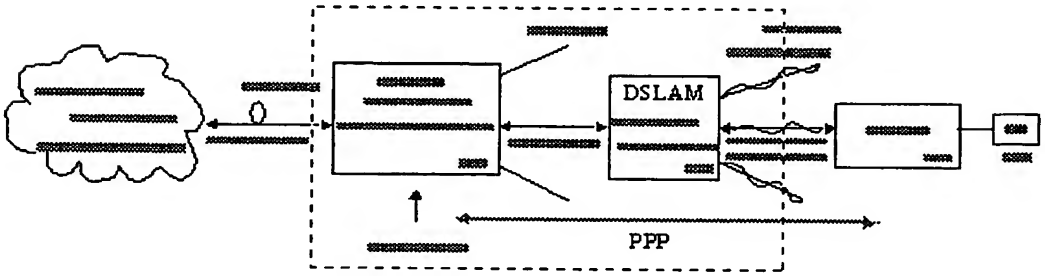

図 10 アクセスネットワークシステム全体構成(第 2 の実施例)

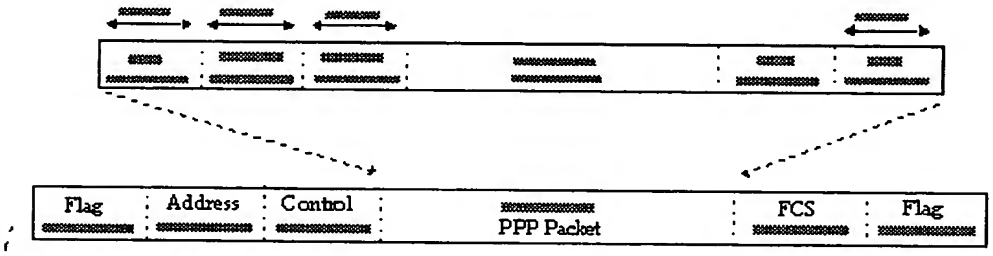

図 11 PPP パケットイン PPP パケットフレームフォーマット

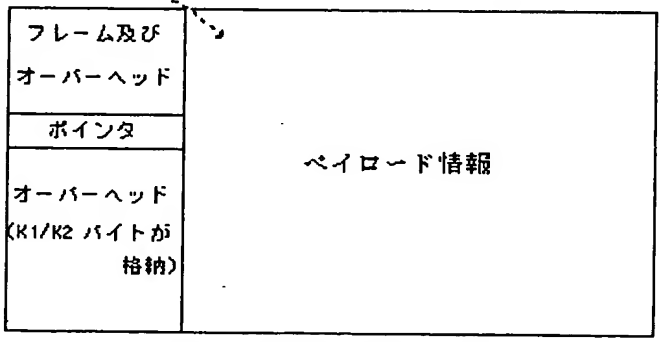

図 12　SDH/SONET のフレーム構成

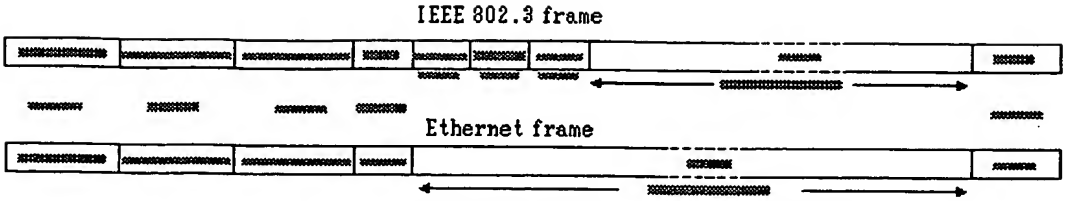

図 13 Ethernet/IEEE802.3 パケットフォーマットの違い

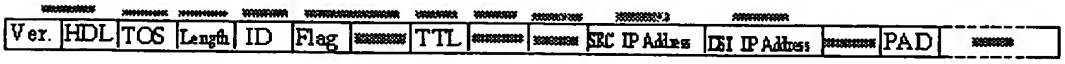

図 14 IP パケットフォーマット

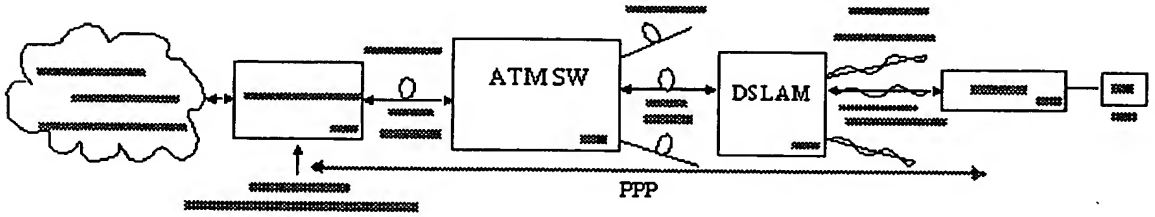

図 15 従来のアクセスネットワークシステム全体構成

[Title of the Invention]

Circuit multiplexer

[Characteristic of the invention]

FIG. 1 shows an entire configuration of an access network system. The present invention is characterized in that, in response to an Internet access request from a PC (101: Personal Computer), PPP (Point-to-Pint Protocol) packet data for carrying IP (Internet Protocol) packet data (see FIG. 8, FIGS. 9-1 to -3 and the section "Background of the Invention") is loaded on an Ethernet frame (or a frame of IEEE 802.3, see detailed drawing FIG. 13, hereinafter abbreviated to Ethernet/802.3) (see RFC 2516), the frame itself is analog modulated so that it can pass through an ADSL (Asynmetric Digital Subscriber Line)/VDSL (Very high speed Digital Subscriber Line) interface in the figure in an ATU-R as a subscriber and carried to a subscriber multiplexing apparatus DSLAM (Digital Subscriber Line Access Multiplexer), and carried from the DSLAM to an AG (Access Gateway) apparatus through a PHY interface having an Ethernet/802.3 frame, in a system in which each subscriber (terminal) is about to connect to the Internet. A mode of the present invention is applied to all the packets for PPP packet data (for controlling and for IP packet data, see FIG. 9-1 Protocol Field). PPP (see RFC 1161) is for performing authentication (Aucentication → an unregistered subscriber cannot form a Link itself and hence can neither transfer data nor receive an IP address itself), accounting (Accounting → a time being connected), management of service itself (SMS: Service Management System), subscriber-specific band allocation (in this case, ATU-R), ensuring QoS and the like. Specifically, PPP itself is placed at an entrance of an ISP (Internet Service Provider) for having the ISP perform the abovementioned authentication, accounting, service management, allocation of a band for each subscriber and the like (guaranteeing QoS).

As shown in FIG. 15, conventionally, the protocol (PPP) termination performed as DSLAM which processes an ATM cell as a base sets another apparatus dedicated to termination (FIG. 15, block 701) immediately before the IP data (signal upward direction) from a subscriber (ATU-R) being subjected to analog modulation so as to become ATM cell signals (an ATM cell header VPI/VCI differs for each subscriber) which are made into an AAL5 (ATM

Adaptation Layer 5), and pass through ADSL/VDSL interface; carried to the DSLAM; and returned to original digital packet signals and multiplexed at the DSLAM, further multiplexed with similar signals from another DSLAM at an ATM SW (block 601); and entered into a backbone network of the Internet. The identification itself of the subscriber (ATU-R) is performed by uniquely allocated VPI/VCI at the DSLAM. Signals coming from a backbone network or a PPP terminal apparatus (signal downward direction) are separated at the VPI/VCI and carried to each subscriber.

According to the present invention, a PPP header (see FIG. 8) is added to (Encapsulation) packet signals (IP data) from a PC, which is a terminal in the signal upward direction (a terminal: from a PC to an AG: a direction toward an Access Gateway), and further a frame header of Ethernet/802.3 (an MAC address differs for each subscriber, see FIG. 8) is added, and converted into ADSL/VDSL signals at an ATU-R and carried to a DSLAM. At the DSLAM, respective packet signals are written into an FIFO Queuing 202-1 to N (see FIG. 6-2) from the abovementioned MAC address as the top (in this case, a MAC address for each subscriber will be a Source MAC address, see FIG. 4 for further detail of the MAC address) in the block 202 (FIG. 2), and multiplexed. The multiplexed signals are converted into Ethernet/802.3 signals at the block 204 (FIG. 6-1), which performs PHY layer processing, and outputted from the apparatus as signals 2101. Then, processing as PPP protocol signals (see FIGS. 9-2, 9-3) is performed at an AG (Access Gateway), or the subsequent apparatus. In contrast, in signal downward direction (a direction from an AG to a terminal: toward a PC), signals from the block 206, which performs PHY layer processing, are demultiplexed for each packet by an MAC address (in this case, a Destination MAC address, see FIG. 8) which is allocated for each of the abovementioned subscribers as shown in FIGS. 5-1, -2 at the DSLAM. After each demultiplexed packet is written into FIFOs 203-2.1 to 203.2.N (FIG. 5-2) and read out, it is converted into VDSL/ADSL signals and outputted from the block 207, which performs PHY layer processing.

The present invention is characterized in performing not only accounting, authentication but also guaranteeing QoS of each subscriber in the entire access network system by multiplexing or demuliplexing data from a subscriber by using Ethernet packet signals of a variable length packet instead of using a technique as an ATM cell of a fixed length packet at DSLAM, and similarly controlling reservation of an allocated subscriber-specific band, Queuing and the

like which is determined by PPP by distinguishing each subscriber (in this case, each ATU-R) by an MAC address similarly at an AG.

[Embodiments of the invention]

FIG. 1 shows an entire configuration of an access network system including the present invention. In the figure, IP packet data outputted from a terminal (101: PC) toward a backbone network (in a signal upward direction) (see FIG. 14) is subjected to PPP Encapsulation (see FIG. 8) at an ATU-R (102), added with a frame as Ethernet/802.3 (for further detail of an MAC address, see FIG. 4), further subjected to analog modulation, and carried to a (packet base) DSLAM apparatus (201), which makes a variable length packet the base of the processing, through an ADSL/VDSL interface on a metallic cable. At the DSLAM apparatus (201), packet signals from many subscribers (102: ATU-Rs) are multiplexed by using MAC addresses (in this case, Source MAC addresses) allocated for respective subscribers, and outputted as signals (2101) having Ethernet/802.3 frame of about 100 Mb/s. At an AG (301), the packet signals are processed (for details, see background of the invention) at a CPU board (see FIG. 2, block 308) only for packets relating to control processing as a PPP (FIG. 9-1, Protocol Field 8021/c021). PPP Encapsulation headers are once removed from IP packets as the other data (FIG. 3, 3101) and the packets are transferred to a backbone network through a POS interface (Packet Over Sonet/SDH, for a detailed frame format, see FIG. 12) (in this case, as in the former case, PPP Encapsulation needs to be performed on an IP packet, but the Encapsulation, which is different from the abovementioned PPP processing from the subscriber and is detailed in the second embodiment, is performed at an interface block 304). At the AG, controlling is performed including the abovementioned authentication, accounting and the like for each subscriber (see background of the invention). In contrast, a PPP header is removed from packet data (3102) which is subjected to PPP Encapsulation for transferring IP data by a POS interface in a signal downward direction from the backbone network at an interface block (306), subjected to PPP processing (protocol processing for POS: the maximum packet length exchanged with an opposite apparatus: determination of Maximum Transfer Unit size, and the like), and outputted as signals (2102) having an Ethernet/802.3 frame of about 100 Mb/s. At the DSLAM apparatus (201), the signals (2102) having the Ethernet/802.3 frame can distinguish a targeted subscriber by MAC header information (Destination MAC Address, see FIG. 8),

are demultiplexed with the information (Destination MAC Address) and carried to each subscriber (102: ATU-R) through an ADSL/VDSL interface (1102). At the ATU-R (102), the signals are inputted into the PC (101) as an original IP packet which is Ethernet/802.3 and a PPP header removed as header information from the abovementioned received signals (As shown in the figure, if an Ethernet interface is used between the ATU-R and the PC, an MAC address of Source/Destination in the Ethernet/802.3 packet is present. This is the same as the case of a usual LAN, thus, the description of that will be omitted here).

FIG. 2 shows a block diagram in an apparatus for an AG. Operation of the AG will be described here. Packet signals (for the format, see FIG. 8) inputted from the DSLAM apparatus through the Ethernet/802.3 interface (2102) are received at 307, a PHY block, and at this block, the signals are switched by an Ethernet/802.3 packet frame at a packet switch module (FIGS. 2, 3, block 302) by the Source MAC address (this tells which subscriber ATU-R the packet comes from) and outputted to a CPU board (FIGS. 2, 3, block 308) or a POS interface (304). It is determined whether it is IP packet data (value: 0021) or a control packet for Link control (value: 8021 or c021) as Protocol Field values (see FIG. 9-1) in the Ethernet/802.3 packet frame being referenced at an interface block 305.

If it is the IP packet data, a header part (a part other than packet data of Flag/Address/Control/Protocol/FCS/Flag of FIG. 8) of the PPP is removed from the packet (the PPP means termination), transferred to the packet switch module (302), switched and outputted to the backbone network (FIG. 3, signal 3101: the signal format is FIG. 12) through the output interface block (304). In contrast, a Protocol Field value: 0021 (see FIG. 8, FIG. 9-1) for PPP processing toward a subscriber is added to the packet data which is mapped to the POS signals (3102) from the backbone network in the direction of a signal inputted from the backbone network (in a downward direction) at the input interface block (306), transferred again to the packet switch board (302) as a PPP packet, packet switched, and a MAC address (in this case, a MAC address of each subscriber) is added to at 307, a PHY block, outputted to the DSLAM apparatus (FIG. 1, 201) as an Ethernet/802.3 frame, demultiplexed by the MAC address as each subscriber in that, and then transferred to each subscriber (102: ATU-R).

Next, termination of PPP will be described. As it is apparent from FIG. 2, if a PPP packet inputted from the DSLAM side is a packet for Link control (Protocol Field value: 8021/c021),

the packet is switched at the packet switch module (302) and transferred to the CPU board (308). At the CPU board (308), a PPP packet is sent out to each subscriber (ATU-R) to perform the protocol termination (see FIGS. 9-2, 9-3) on the received PPP packet by program control. The PPP packet from the CPU board (308) is transferred to the packet switch module (302), outputted to the DSLAM apparatus through the PHY interface block (307), demultiplexed by an MAC address (in this case, an MAC address of each ATU-R is a Destination MAC address) as in a usual data packet, transferred to each user (ATU-R), and subjected to PPP processing between the subscriber and the AG.

[Constitution of embodiments] [Description of operation of the embodiments]

FIG. 2 and FIG. 3 show detailed block diagrams inside apparatuses of AG (Access Gateway) and DSLAM apparatuses in the present invention. Detailed operation of each component will be shown below with reference to the detailed block diagrams FIG. 2 and FIG. 3.

First, the DSLAM apparatus consists of an Ethernet/802.3 interface block (204/206) which inputs/outputs signals to/from a backbone side, an ADSL/VDSL interface block (205/207) which inputs/outputs signals to/from a subscriber side, a demultiplexing block 203 for allocating an Ethernet/802.3 packet inputted from the backbone to each subscriber based on an MAC address, a block 202 which multiplexes a packet having an Ethernet/802.3 frame inputted from each subscriber, and the like.

FIGS. 5-1, -2 show a case where a packet having an Ethernet/802.3 frame coming from the backbone side (in a signal downward direction) is demultiplexed. First, a packet signal 2102 coming from the backbone side (for the frame format, see FIG. 8) is received at 206, a PHY block. It is outputted from 206 as a packet signal 2102-2 (the signal format is the same). The packet is demultiplexed as each subscriber is distinguished from a Destination MAC address to an ATU-R, and the top Destination MAC address of the packet is detected at a filtering block 203-1 (FIG. 5-2).

Setting of the MAC address will be described with reference to FIG. 4. As it is apparent from the figure, a signal 2102 from the AG has 2011/3011 (2011 is an address of a port toward each ATU-R in the DSLAM, and 3011 is an address of a port toward each DSLAM at

the AG) as a Destination/Source MAC address or 1021/3011 (1021 is an address for each ATU-R, and 3011 is an address of a port toward each DSLAM at an AG) and is inputted into the Filtering Block 203-1. As each port for a DSLAM subscriber (an ADSL/VDSL interface) is connected to an ATU-R one to one, the Destination address may be either 2011 or 1021. As subscribers are identified in the DSLAM, the subscribers can be divided. In FIG. 5-2, signals which are a packet having 2011/3011 as an MAC address is inputted in a block 203-1 are written by a Filtering into an FIFO203-2.1. Here, according to FIG. 14, as the number of bytes of the entire packet can be recognized as a Length field at the third to the fourth byte from the top in the IP packet of the inputted packet (2102-2) is referenced, the signals only need to be written into an FIFO by the number of the byte. As mentioned above, the FIFO is reserved for the capacity of the longest packet, and a shaping function (described later for further detail) in the AG eliminates packets remaining before the currently arrived packet. Thus, the FIFO can always receive the longest packet written into there. The packet which has been written into the FIFO 203-2.1 is immediately enters into reading out operation, and outputted from the block 207 at an interface speed as ADSL/VDSL (for example, about 6 Mb/s) as a packet signal 1102. Although all the MAC addresses in this case need to be changed to 1021/2011 at the block 207 (for all the packets of 2011/3011 or 1021/3011 as the abovementioned Destination/Source MAC address), all the packets received at ATU-R are processed as those destined to the ATU-R as the ATU-R is connected one to one to N subscribers in all. That is, 207 and 205 which are ADSL/VDSL interface PHY blocks correspond to each subscriber. In the figure, 205 corresponds to ATU-R102. Packets are processed to the other ports in the same manner.

FIGS. 6-1, -2 shows a case where a packet having an Ethernet frame coming from the subscriber side (in a signal upward direction) is multiplexed. Packet signals 1101 coming from the subscriber side through an ADSL/VDSL interface (for the frame format, see FIG. 8 as that in the upward direction) are received at 205, a PHY block. The packet signals 1011 inputted by the subscriber (ATU-R 102) into 205 are once written into the FIFO 202-1 (the number of FIFOs is N, the same as that of subscriber lines. The capacity of an FIFO will be described later.). In the figure, as the number of bytes of the entire packet can be recognized as a Length field at the third to the fourth byte from the top of the IP packet of the inputted packet (1101) (see FIG. 14) is referenced similar to the signal downward direction, the signals only need to be written into an FIFO by the number of bytes. The respective packets can be

multiplexed after they are written into FIFOs and then read out from each of the FIFOs (from 202-2 to 202-N) in order. In this case, each subscriber is identified by an MAC address allocated for each subscriber as in the signal downward direction. Setting of the MAC address in such a case (in a signal upward direction) will be described with reference to FIG. 4 as in the signal downward direction. As it is apparent from FIG. 4, a signal 1101 from the subscriber (ATU-R 102) has 2011/1021 (1021 is an address of ATU-R 102, and 2011 is an address of the port in the DSLAM) as a Destination/Source MAC address and is inputted into an FIFO Queuing Block 202-1. The packet signals (1103 to 110N) form the other subscribers (ATU-Rs 112-) are similarly inputted into FIFO Queuing Blocks 202-2 to N respectively. For the multiplexed packets, those added with 2011 or 1021 as a Source MAC address for identifying a subscriber are multiplexed as they are and outputted as a packet 2101 signal having an Ethernet/802.3 frame from the DSLAM.

For the guaranteeing QoS, the term "QoS" here means that a band set for each subscriber is reserved; no packet drop occurs; and delay in signal transmission is the minimum. The setting of a band, shaping of traffic and the like are assumed to be performed for each flow (for example, packet data toward a targeted MAC address) at the AG (Access Gateway) in the conventional ATM SW. For example, traffic shaping or delay will be described with reference to FIG. 7-1. At the AG, flows to be inputted are all stored in memory inside the packet switch module (302) which processes each packet, and the memory has Queuing done in pieces as shown in FIG. 7-1. For example, the port (307) toward the DSLAM in the signal downward direction has Queuing done in (302) for each subscriber. Each Queue is given an order of priority (302-1.1, 302-1.2, 302-1.3 ...). For example, as packet signals toward an ATU-R 102, a subscriber, have Queuing done in 302-1.1, they are processed preferentially to the other packet signals, thus, have the minimum delay, and outputted by the port (307). If a band to be reserved is 6 Mb/s, traffic shaping is done so that the maximum band is 6 Mb/s. The packet signals outputted from the output port (307) of the AG is demultiplexed as the top of the MAC address of the packet is detected in the filtering block 203-1 in the DSLAM. The separated packet signal 2103-3 (see FIG. 5-2) is written into an FIFO203-2.1. If the throughput of an ADSL/VDSL interface for each subscriber is assumed to be 6 Mb/s, packets are always written into the FIFO203-2.1 at a rate of 6 Mb/s and read out at a rate of 6 Mb/s. Therefore, FIFO memory for the maximum packet length byte for a packet is needed for each FIFO if the QoS is to be met. Even if a packet length is get longer

and exceeds the capacity of the FIFO203-2.1, the shaping function in the AG fragments (segments) the packet so as to prevent it from being over-flown from the FIFO.

In contrast, in the signal upward direction, packet data from each subscriber (for example, an ATU-R 102) has a low throughput for the ADSL/VDSL interface, such as several 100 kb/s order. Unless a packet is read out even with the several 100 kb/s, the packet clogs at the FIFO202-1 in the DSLAM and destroys the data. Each of the FIFOs 202-1 to N in FIG. 6-2 has the capacity of the maximum packet length byte of one packet. The packets are read out from each of the FIFOs to the Ethernet interface block 204 at the throughput of about 100 Mb/s and outputted as signals (2101) having an Ethernet/IEEE802.3 frame. Here it is described only for signals from a subscriber ATU-R 102, N subscribers are (ATR-R IN2) are assumed to be present in all. Conversion into a signal (2101) having an Ethernet/IEEE802.3 frame is performed at the PHY block (204). Each packet arrived at the AG has Queuing done in pieces because it is stored for each flow as shown in FIG. 7-2 in the packet switch module (302) which processes each packet, as it is described in a signal downward direction. Upward packet signals coming from the DSLAM has Queuing done in (302) for each subscriber. Each Queue is given an order of priority (302-2.1, 302-2.2, 302-2.3 ...). For example, as a packet signal from an ATU-R 102, a subscriber, has Queuing done in 302-1.1, it is processed preferentially to the other packet signals with the minimum delay and outputted from the AG to a backbone network or a CPU board. In such a case, although an upward signal speed is as much as several 100 kb/s order, it is subjected to traffic shaping as a band to be reserved is 6 Mb/s as similar to the downward.

Now, detailed operation will be described by taking an example of PPP packet processing (see FIG. 2 and FIG. 3) in the AG. As shown in FIG. 2, in the AG (301), only packets relating to control processing as a PPP among the packet signals (FIG. 9-1, Protocol Field 8021, c021) are processed at the CPU board (see FIG. 2, block 308). A PPP Encapsulation header which is used with each subscriber ATU-R is once removed from the IP packet (FIG. 3, 3101) at a POS (OC-12c) interface block (304) as the other data, and another PPP Encapsulation for POS (format itself is the same, but exchanges information in the maximum transfer packet length: MTU size or the like with the opposite POS interface) is performed and transferred to the backbone network through the POS interface. For processing of a packet relating to control processing as a PPP in the CPU board (FIG. 9-1, Protocol Field

8021, c021), the CPU board (FIG. 2, block 308) transfers a control packet between the CPU board (308) and each ATU-R as shown in FIG. 2 to perform processing for FIGS. 9-2, -3 (Link Control Protocol, or Network Control Protocol), if a PPP packet having Protocol Field 8021, c021 is coming from a subscriber. When exchange of a protocol necessary to establish Link finishes, each subscriber (ATU-R) exchanges IP packet data with an actual backbone network (the Internet) as shown in FIG. 3 and accesses the Internet.

Controlling including the abovementioned authentication, accounting and the like is performed on each subscriber at the AG, as the abovementioned control information of a PPP packet is exchanged. A PPP header is added to or deleted from each packet signals (FIG. 1, 3101/3102) between the backbone network and the AG for the PPP Encapsulation (different from the abovementioned PPP processing by the subscriber, see FIGS. 11, 12) at an interface block (304/306) for transferring IP data by POS. As mentioned above, after the PPP processing at the POS, PPP processing (protocol processing and Encapsulation) is performed anew as signals (2102) having an Ethernet/802.3 frame of about 100 Mb/s and inputted/outputted.

[Description of Advantage]

As mentioned above, the present invention has an advantage in ensuring QoS of each subscriber with a simple and inexpensive apparatus configuration by efficiently processing PPP packet signals (perform controlling such as authentication, accounting and the like) from a subscriber and without using the AAL5, an ATM cell assembly/disassembly function, as it realizes a function as an AG (Access Gateway) in a system shown in FIG. 1 and a function of the DSLAM realized in a conventional ATM base by packet based processing (including distinguishing of subscribers).

[Other embodiments of the invention]

FIG. 10 shows an entire configuration of an access network system including the present invention as a second embodiment. It is different from the first embodiment in that optical signals (OC-3c) having a POS Frame are used to extend a transmission distance instead of configuring an Ethernet/802.3 interface (2101/2102) between the DSLAM and the AG. Its

operation as an access network system is almost the same as that of the first embodiment. If optical signals having a POS Frame are used between the DSLAM and the AG (OC-3c, see FIG. 12) a packet subjected to the abovementioned PPP processing for determining the MTU size and transmitted between them needs to be subjected to the PPP Encapsulation. As signals from each subscriber, an ATU-R, are originally subjected to the PPP Encapsulation, the PPP packet is further subjected to the PPP Encapsulation (see FIG. 11). Basic operation will be described below with reference to FIG. 10. IP packet data outputted from a terminal (101: PC) toward the backbone network passes through an ADSL/VDSL interface on a metallic cable as it is and the packet is multiplexed as it is at the ATU-R (102), outputted as OC-3c signals having a POS (Packet Over SONET) interface, or carried to the DSLAM apparatus (201) which performs packet based demultiplexing as POS OC-3c signals. They are multiplexed with signals from many subscribers (102: ATU-R) at the DSLAM apparatus (201) of the packet base and outputted as an OC-3c signals (2101) having a POS Frame of 155 Mb/s.

For packet signals (2101) which are inputted at the AG (301) as the second embodiment, only a packet (see FIG. 2) relating to PPP control processing with a subscriber is outputted to the CPU board (308) through a packet switch module (302). The CPU board performs PPP processing by exchanging a packet with each ATU-R. The PPP processing (assuming it is PPP 1) here means exchange between a CPU board in an AG and an ATU-R and is different from the PPP processing between the DSLAM and the AG (assuming it is PPP 2). Processing as PPP2 is a protocol which is needed when the DSLAM and the AG are connected by a POS interface. PPP link processing and processing sequences themselves are as shown in FIG. 9-2. If the DSLAM and the AG are connected by a POS interface, the PPP2 is needed and is terminated between POS interface blocks 307 and 206, and 305 and 204 in FIG. 2. In the blocks, the first PPP Encapsulation in FIG. 11 is removed and carried to the next block in a packet (having Encapsulation of PPP1). PPP2 sets the maximum packet length (Maximum Transfer Unit: MTU size) which is transferred between POS interfaces of the AG and the DSLAM, instead of performing the abovementioned management, controlling of subscribers (authentication, accounting, service management, subscriber-specific band allocation, and the like). For the PPP1, it is performed in the similar manner to that in the first embodiment in the AG. Although an MAC address is used for identifying a subscriber in the packet based DSLAM in the first embodiment, a subscriber

cannot be identified in the second embodiment because the MAC address is not present in the second embodiment as shown in FIG. 11. Then, a PPP packet coming from the backbone side (in a signal downward direction) through the POS interface (2101/2102) is separated by using an IP address assigned to each subscriber (see Filtering Block filtering block 203-1 (FIG. 5-2), easily obtained as 17th to 20th bytes from the top of the IP packet in the PPP packet is viewed) to be demultiplexed for each subscriber (ATU-R), instead of Destination MAC address to the ATU-R. The other operation for demultiplexing is the same as that of the first embodiment. That is, since a subscriber is distinguished in the DSLAM, it is assumed that each port to a subscriber of the DSLAM has any MAC Destination address (ADSL/VDSL interface connected to an ATU-R one to one) but uses what previously assigned as in the first embodiment.

In the second embodiment, the manner by which packets having Ethernet frames coming from the subscriber side in the signal upward direction are multiplexed is also the same as in the first embodiment. That is, a packet signal 1101 which comes from the subscriber side through the ADSL/VDSL interface is received at 205, a PHY block. Each packet has an IP packet unique to a subscriber, and the Ethernet/802.3 frame is removed at the block 205 and multiplexed. As it is outputted from a POS interface from the block 204, the PPP packets are subjected to the PPP Encapsulation again to be outputted through the POS interface as shown in FIG. 11.

[Background of the invention]

Background of a terminating method of a PPP (Point-to-Point protocol) according to the present invention and multiplexing of signals from a subscriber to a network (the Internet) will be described. As mentioned above ("Characteristic of the invention"), usually, termination of a PPP is performed at an entrance of the ISP for transferring an IP packet. The PPP termination itself is conventionally addressed by setting a dedicated appliance (see FIG. 15). A PPP is a link protocol which must be established at sending out an IP packet in connecting to the Internet for the first time, and placed under the IP layer (see FIGS. 9-1 to -3). A PPP Frame format in a HDLC form is as show in FIG. 8. In the payload, a Protocol field of 32 bits is added to it and then IP packet is inserted as packet data. As the protocol itself for establishing a link is not complicated (see FIGS. 9-2, -3) but since a PPP frame which has

conventionally been subjected to the PPP Encapsulation at an ATM cell using the AAL5 is sent out, processing of SAR of the AAL5 is needed for terminating the PPP at first. The SAR function builds an original PPP frame and the CPU performs processing for establishing a link. A subscriber can transfer an IP packet to a network (the Internet) after the link is established. As such, an apparatus having functions for selecting each subscriber who tries to access the Internet and processing the protocol (FIG. 15, 701) has been set at an entrance of the backbone network (the Internet). Basically, since an IP packet was mapped to an ATM cell and information was communicated, it has been complicated and expensive as the entire system for ensuring Qos of a subscriber. The apparatus (FIG. 15, 701) was often set near the backbone network (the Internet) to which many subscribers are multiplexed.

A main object of the present invention is to provide an apparatus having the present function nearer to a subscriber, i.e., in an apparatus providing an internet service (FIG. 1, 301) when apparatuses having the present function are added on as the subscribers who access the Internet increases in order to ensure QoS of each of the individual subscribers and pass Ethernet/802.3 packet data from a subscriber through an interface such as a VDSL or an ADSL as it is without using an ATM layer so that a simpler apparatus configuration is realized without performing segmentation of packet data by the AAL5 and increase of subscribers is more flexibly addressed.

Meaning of PPP terminal processing will be summarized below.

Management of a subscriber who tries to connect to the Internet, i.e., a terminal point of PPP is an entrance to the Internet or a provider (ISP)

Specifically,

- Authentication (Aucentication) → an unregistered subscriber cannot form a Link itself and hence can neither transfer data nor receive an IP address,
- Accounting → a time being connected,

Then manage service itself (SMS), and

- Subscriber-specific band allocation and the minimum delay (ensuring QoS)

A PPP is a protocol for supporting data transfer of a multi-protocol on a peer-to-peer circuit. A frame structure of HDLC-like as a PPP Frame format is shown in FIG. 8.

In the processing in a PPP, a Link needs to be established (authentication as a user is performed thereafter). As it is shown in FIG. 9-1, a Link is established by an LCP packet (distinguished by a value of Protocol Field) and then Configuration is performed for data transfer at a higher layer by an NCP packet (Network Control Protocol). Thereafter, user packet data is transferred.

* Reference; IETF Document RFC1161/1162/1332/2516, IEEE 802.3

[Scope of right]

A packet multiplexing and demultiplexing method from a subscriber (ATU-R) by an MAC address in a packet processing based DSLAM in FIG. 1. A packet multiplexing and demultiplexing method from a subscriber (ATU-R) by the IP ω MAC address conversion in the packet processing based DSLAM having a POS interface in the second embodiment in FIG. 10; and a further PPP Encapsulation method of a packet which is subjected to PPP Encapsulation from a subscriber for inputting and outputting a POS interface. A control method such as authentication, accounting, ensuring QoS and the like for a subscriber by the PPP packets in an AG. An inner configuration and a specific method as the packet base DSLAM and AG.

[Searching expression in self searching before filing]

"PPP" + "authentication" + "accounting" + "QoS" + "Packet Over Sonet" + "MAC address" + "multiplexing" + "demultiplexing" + "ADSL" + "VDSL" + "ISP" + DSLAM" + "the Internet" + "access gateway"

[the Patent Laid-Open number, the Patent Publication number or the Patent number supposed to relate with the present invention]

Protocol termination apparatus (Japanese Patent Application No. 2000-252443, NEC Corporation, Yoshitaka Fujita)

[Keywords for search]

"PPP" + "authentication" + "accounting" + "QoS" + "Packet Over Sonet" + "MAC address" + "multiplexing" + "demultiplexing" + "ADSL" + "VDSL" + "ISP" + DSLAM" + "the Internet" + "access gateway"

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PPPはpeer-to-peerの回線上でマルチプロトコルのデータ転送をサポートするプロトコルである。図8に示したのがPPP Frameフォーマットとしての HDLC-likeのフレーム構造である。

PPPの処理においてはLinkの確立（この後ユーザーとしての認証が行われる）が必須である。図9-1に示されているようにLCPパケット（Protocol Fieldの値で区別）によりLinkを確立し、次いでNCPパケット(Network Control Protocol)による上位層のデータ転送の為のConfigurationを行う。この後ユーザーパケットデータが転送される。

※出展IETF Document RFC1161/1162/1332/2516、IEEE 802.3

【権利範囲】

図1におけるパケット処理ベースのDSLAMにおいてのMACアドレスによる加入者（ATU-R）からのパケット多重及び多重分離方法。図10第二の実施例におけるPOSインタフェースを持ったパケット処理ベースのDSLAMにおいてのIP⇔MACアドレス変換による加入者（ATU-R）からのパケット多重及び多重分離方法、またPOSインタフェースに入出力させる為加入者からPPP Encapsulationされたパケットのさらなる PPP Encapsulation方法。AGにおけるそれらPPPパケットによる加入者の認証、課金及びQoSの確保等々の制御方法。パケットベースDSLAM及びAGとしての内部構成及び具体的方式。

【届出前自主サーチにおける検索式】

『PPP』＋『認証』＋『課金』＋『QoS』＋『Packet Over Sonet』＋『MACアドレス』＋『多重化』＋『多重分離化』＋『ADSL』＋『VDSL』＋『ISP』＋『DSLAM』＋『インターネット』＋『アクセスゲートウェイ』

【本発明に関連すると思われる公報の公開、公告または特許番号】

プロトコル終端装置(特願2000-252443、日本電気株式会社、 藤田 佳賢)

【サーチのためのキーワード】

『PPP』＋『認証』＋『課金』＋『QoS』＋『Packet Over Sonet』＋『MACアドレス』＋『多重化』＋『多重分離化』＋『ADSL』＋『VDSL』＋『ISP』＋『DSLAM』＋『インターネット』＋『アクセスゲートウェイ』

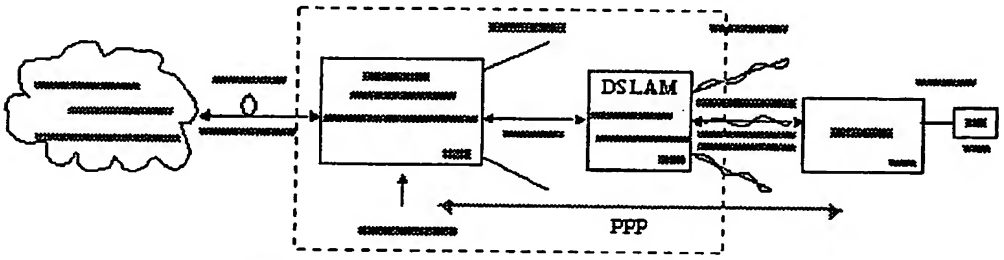


図1 アクセスネットワークシステム全体構成

FIG.1 ENTIRE CONFIGURATION OF ACCESS NETWORK SYSTEM

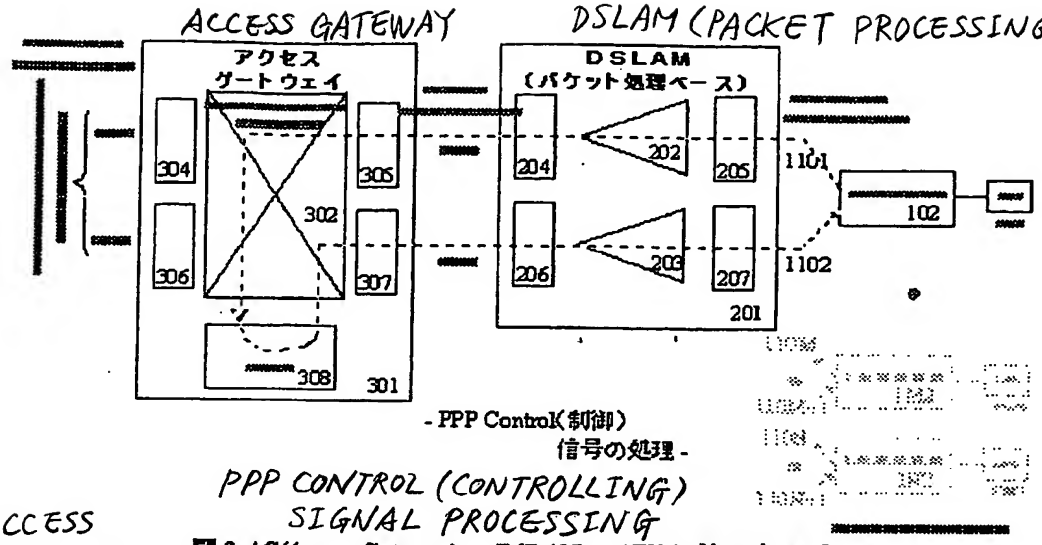


図 2 AG(Access Gateway)～DSLAM～ATU-R 処理ブロック

FIG.2 AG (ACESS GATEWAY)-DSLAM-ATU-R PROCESSING BLOCK

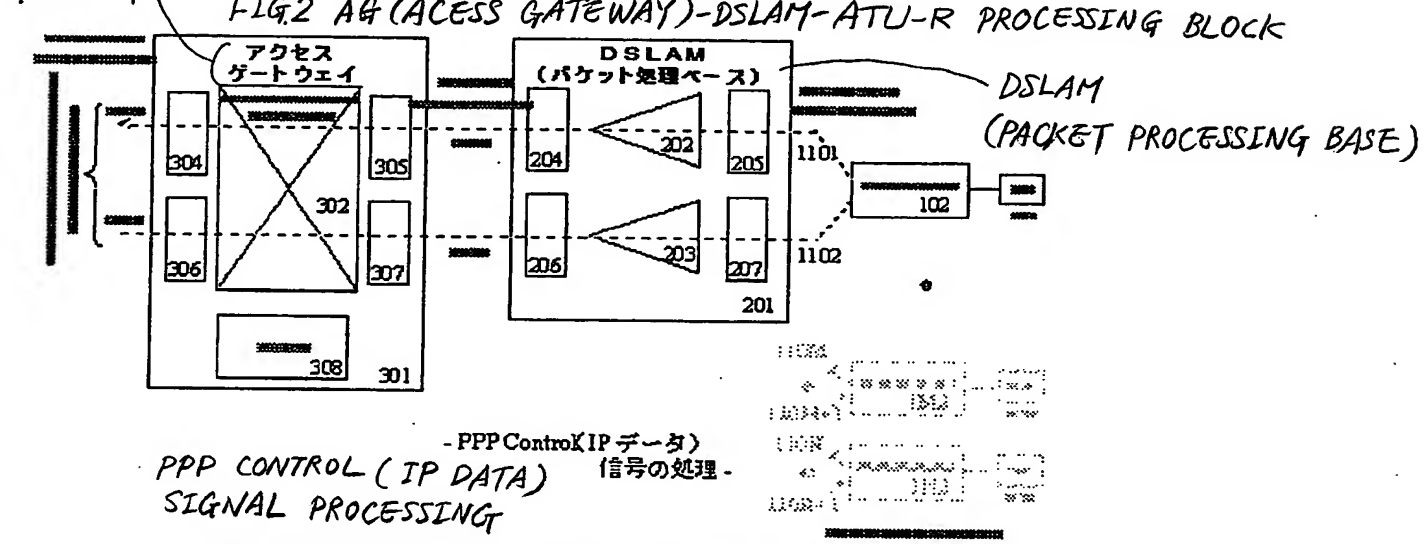


図 3 AG(Access Gateway)～DSLAM～ATU-R 処理ブロック

FIG. 3 AG(ACCESS GATEWAY)-DSLAM-ATU-R PROCESSING BLOCK

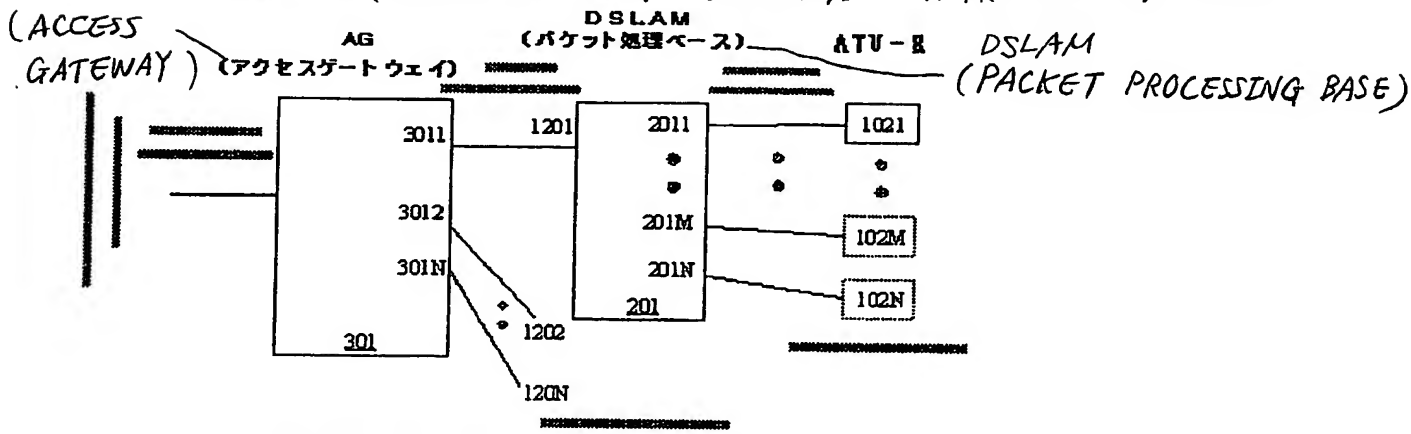


図 4 各装置に割り振られた MAC アドレス

FIG. 4 MAC ADDRESS ASSIGNED TO EACH APPARATUS

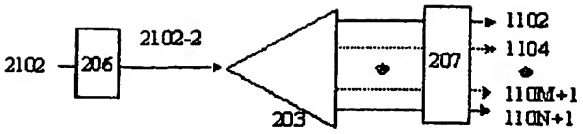


図 5-1 203 Block の詳細機能について

FIG. 5-1 DETAILED FUNCTION OF 203 Block

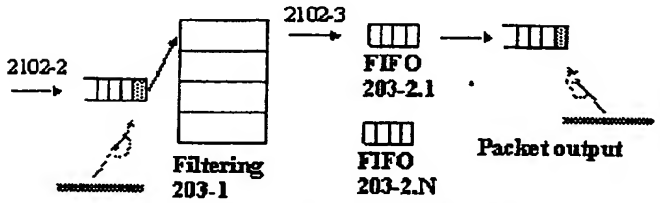


図 5-2 MAC アドレスによる加入者判別

FIG. 5-2 SUBSCRIBER DISCRIMINATION BY MAC ADDRESS

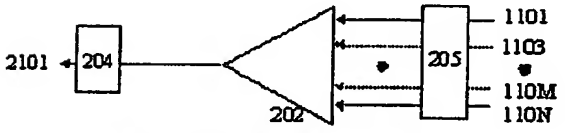


図 6-1 202 Block の詳細機能について

FIG. 6-1 DETAILED FUNCTION OF 202 Block

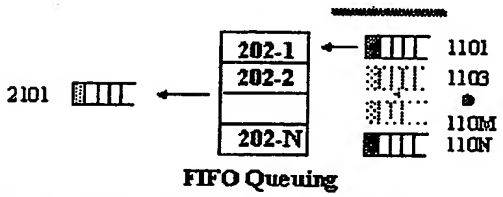
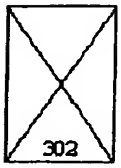


図 6-2 MAC アドレスによる加入者からのパケット多重

FIG. 6-2 PACKET MULTIPLEXING FROM SUBSCRIBER BY MAC ADDRESS



パケットスイッチモジュール PACKET SWITCH MODULE

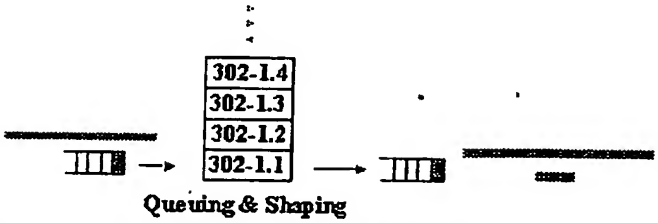


図 7-1 パケットスイッチモジュール (302) 詳細について

FIG.7-1 DETAILS OF PACKET SWITCH MODULE (302)

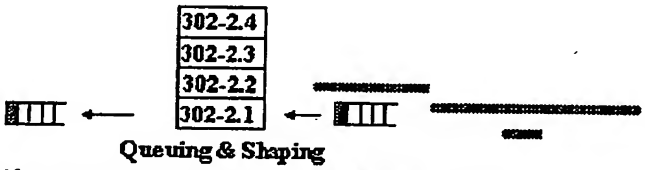
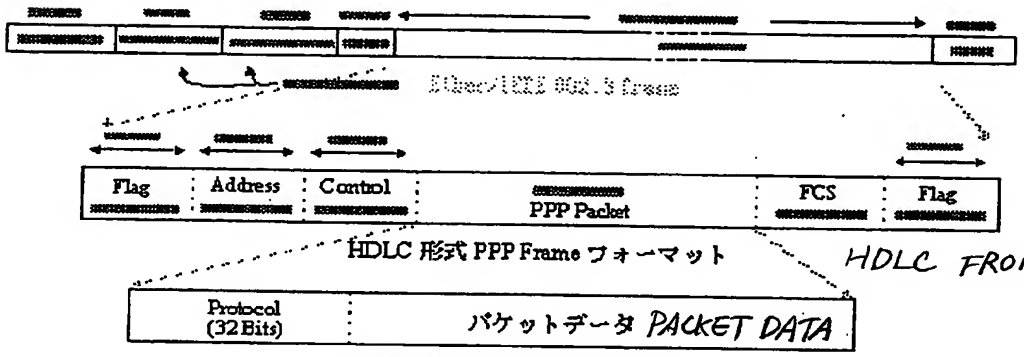


図 7-2 パケットスイッチモジュール (302) 詳細について

FIG.7-2 DETAILS OF PACKET SWITCH MODULE (302)



HDLC FROM PPP FRAME FORMAT

図 8 PPP パケットフォーマット

FIG. 8 PPP PACKET FORMAT

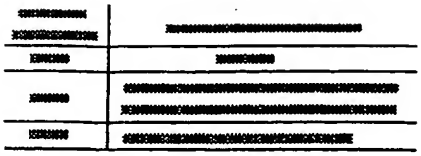


図 9-1 Protocol Field 値とパケットデータとの対応

FIG. 9-1 CORRELATION BETWEEN PROTOCOL FIELD VALUE AND PACKET DATA

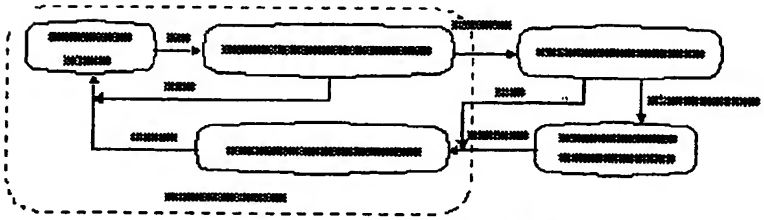


図 9-2 PPP Link 処理

FIG. 9-2 PPP LINK PROCESSING

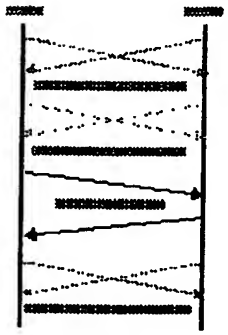


図 9-3 PPP 処理シーケンス

FIG. 9-3 PPP PROCESSING SEQUENCE

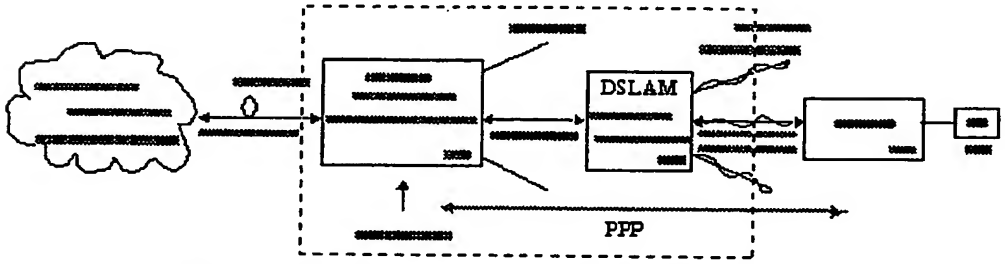


図 10 アクセスネットワークシステム全体構成(第2の実施例)

FIG. 10 ENTIRE CONFIGURATION OF ACCESS NETWORK SYSTEM (SECOND EMBODIMENT)

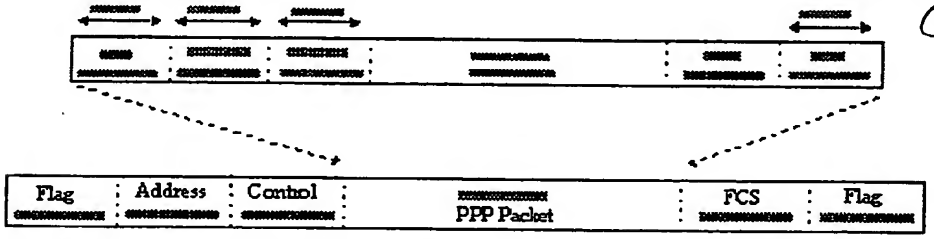


図 11 PPP パケットイン PPP パケットフレームフォーマット

FIG. 11 PPP PACKET IN PPP PACKET FRAME FORMAT

FRAME AND OVERHEAD

POINTER

OVERHEAD (STORED K1/K2 BYTE)

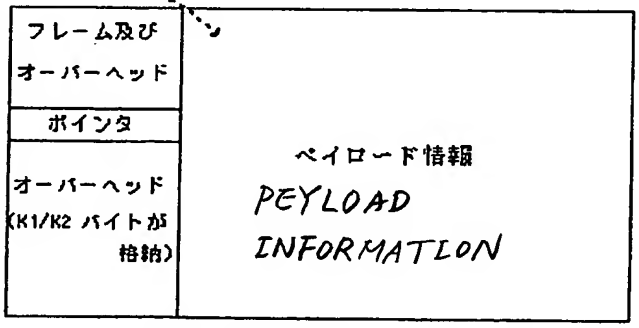


図 12 SDH/SONET のフレーム構成

FIG. 12 FRAME CONFIGURATION OF SDH/SONET

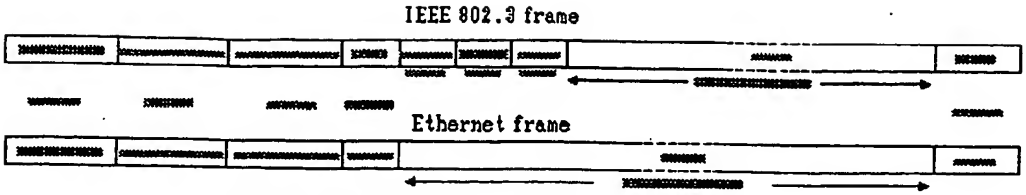


図 13 Ethernet/IEEE802.3 パケットフォーマットの違い

FIG. 13 DEFFERENCE IN PACKET FORMAT BETWEEN ETHERNET AND IEEE 802.3

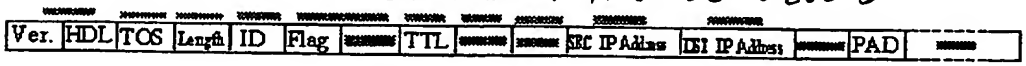


図 14 IP パケットフォーマット

FIG. 14 IP PACKET FORMAT

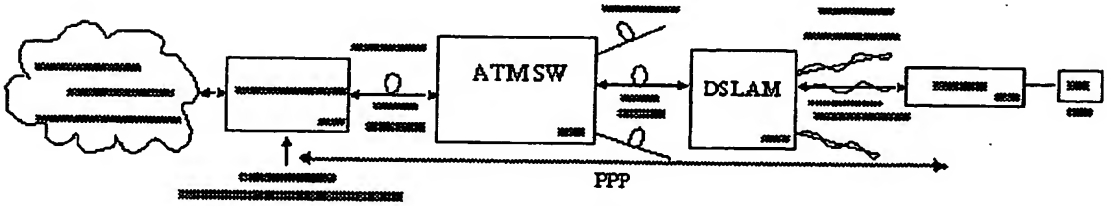


図 15 従来のアクセスネットワークシステム全体構成

FIG. 15 ENTIRE CONFIGURATION OF CONVENTIONAL ACESS NETWORK SYSTEM

APPENDIX B

VERIFIED ENGLISH TRANSLATION OF THE PRIORITY DOCUMENT

P14979-A

VERIFICATION OF TRANSLATION

Patent Application No. 2001-012997

in Japan

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Shuwa-Tameike Building, 4-2, Nagatacho 2-chome,
Chiyoda-ku, Tokyo, Japan ,

am the translator of the documents attached and I verify that the attached is a true translation to the best of my knowledge and belief.

Signature of translator: Kiyotaka Ochiai
Kiyotaka Ochiai

Date: August 4, 2006

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: January 22, 2001

Application Number : 2001-012997

Applicant(s) : NEC Corporation

December 7, 2001

Commissioner,
Patent Office

Kouzou Oikawa

Certif. 2001-3106412

[Document Name] Application

[Reference Number] 49220169

[Date of Application] January 22, 2001

[To] Commissioner, Patent Office

[International Classification of Patent] H04L 12/56

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[Telephone Number] 048-825-8201

[Indication of fees]

[Payment Way] Prepayment

[Prepayment Register Number] 038106

[Payment Amount] 21000

[List of Exhibits]

[Exhibits] Specification one

[Exhibits] Drawings one

[Exhibits] Abstract one

[General Authorization Number] 9407736

[Proof Required or Not] Required

[Document Name] Specification

[Title of the Invention] Multiplexing Method and Apparatus, Demultiplexing Method and Apparatus, and Access Network System

[Claim or Claims]

[Claim 1] A multiplexing method of multiplexing communication signals from communication signal transmitting sections and transmitting a multiplexed signal to a multiplexed signal receiving section, comprising the steps of:

adding, to each of the communication signals, an identification address preassigned to a predetermined signal identifying section through which a communication signal passes in a multiplexing system including the communication signal transmitting section and the multiplexed signal receiving section and outputting each of the communication signals;

extracting the identification address from each output signal; and

multiplexing the respective communication signals on the basis of the extracted identification addresses.

[Claim 2] A method according to claim 1, wherein the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[Claim 3] A demultiplexing method of receiving a multiplexed signal obtained by multiplexing a plurality of communication signals from a multiplexed signal transmitting section, demultiplexing the signal into communication signals, and transmitting the

demultiplexed communication signal to a communication signal receiving section, comprising the steps of:

adding, to each of the communication signals, an identification address preassigned to a predetermined signal identifying section through which a communication signal passes in a multiplexing system including the multiplexed signal transmitting section and the communication signal receiving section, and outputting each of the communication signals;

extracting the identification address from the output signal; and

demultiplexing the multiplexed signal for each of the communication signals on the basis of the extracted identification address.

[Claim 4] A method according to claim 3, wherein the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[Claim 5] A demultiplexing method of demultiplexing a multiplexed signal obtained by multiplexing a plurality of packet into packets, comprising the steps of:

extracting an IP address from each packet in the received multiplexed signal; and

demultiplexing the multiplexed signal into PPP packets on the basis of the extracted IP addresses.

[Claim 6] A multiplexing apparatus which is connected to communication paths of communication signal transmitting sections, multiplexes communication signals from the communication paths, and transmits a multiplexed signal to a multiplexed signal receiving section through a multiplex communication path,

comprising:

address extracting means for extracting an identification address, for each communication signal, which is added to the communication signal received from each of the communication paths and preassigned to a predetermined signal identifying section through which the communication signal passes in a multiplexing system including the communication signal transmitting section and the multiplexed signal receiving section; and

multiplexing means for multiplexing the communication signals received from the respective communication paths on the basis of the identification addresses set for the respective communication signals extracted by said address extracting means.

[Claim 7] An apparatus according to claim 6, wherein the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[Claim 8] A demultiplexing apparatus which is connected to a multiplexed signal transmitting section through a multiplex communication path, demultiplexes a multiplexed signal received from the multiplex communication path, and transmits demultiplexed communication signals to a communication signal receiving section through communication paths for the respective communication signals, comprising:

address extracting means, connected to the multiplex communication path, for extracting an identification address, for each of the communication signals, which is added to each of the communication signals in the multiplexed signal received from the multiplex communication path and preassigned to a

predetermined signal identifying section through which a communication signal passes in a demultiplexing section including said multiplexed signal transmitting section and said communication signal receiving section; and

demultiplexing means for demultiplexing the multiplexed signal into the respective communication signals on the basis of the identification addresses of the respective communication signals which are extracted by said address extracting means.

[Claim 9] An apparatus according to claim 8, wherein the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[Claim 10] A demultiplexing apparatus which is connected to a multiplex communication path through which a multiplexed signal obtained by multiplexing packets addressed to subscriber apparatuses is transmitted, demultiplexes the multiplexed signal received from the multiplex communication path, and outputs each demultiplexed communication signal, comprising:

address extracting means, connected to the multiplex communication path, for extracting an IP address of each packet in the multiplexed signal received from the multiplex communication path; and

demultiplexing means for demultiplexing the multiplexed signal into the respective packets on the basis of the IP addresses of the respective packets extracted by said address extracting means.

[Claim 11] An access network system comprising:

a plurality of subscriber apparatuses which

transmit/receive one of a signal having a MAC address added to a packet and a signal having no MAC address added to a packet;

a subscriber multiplexing/demultiplexing apparatus which multiplexes packets in signals transmitted from said respective subscriber apparatuses on the basis of MAC addresses added to the packets or IP addresses of the packets, and demultiplexes an input multiplexed signal into packets on the basis of one of a MAC address added to each packet and an IP address of each packet; and

a protocol termination apparatus which includes a first interface block which interfaces with a backbone network, second and third interface blocks which interface a multiplexed signal with said subscriber multiplexing/demultiplexing apparatus, switching means, and PPP processing means,

wherein when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a data packet, said protocol termination apparatus causes said switching means to switch to transfer the data packet to said first interface block on the basis of one of a MAC address added to the data packet and an IP address of the packet, and transmits the packet to a backbone network upon converting the packet into a POS signal by using said first interface block, and

when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a control packet, said protocol termination apparatus

causes said switching means to switch to transfer the control packet to said PPP processing means on the basis of one of a MAC address added to the control packet and an IP address of the packet, and causes said PPP processing means to transmit the received control packet through said third interface block and perform PPP processing with said subscriber apparatus through said subscriber multiplexing/demultiplexing apparatus.

[Claim 12] A system according to claim 11, wherein the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet, the data packet is one of a PPP data packet in the Ethernet frame packet and a PPP data packet in the IEEE 802.3 frame, and the control packet is one of a PPP control packet in the Ethernet packet and a PPP control packet in the IEEE 802.3 frame.

[Claim 13] A system according to claim 11, wherein the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet, the data packet is one of a PPP data packet in the Ethernet frame packet and a PPP data packet in the IEEE 802.3 frame, and the control packet is one of a PPP control packet in the Ethernet packet and a PPP control packet in the IEEE 802.3 frame.

[Claim 14] An access network system comprising:

a plurality of subscriber apparatuses which transmit/receive one of a signal having a MAC address added to a packet and a signal having no MAC address added to a packet;

a subscriber multiplexing/demultiplexing apparatus which multiplexes packets in signals

transmitted from said respective subscriber apparatuses on the basis of MAC addresses added to the packets or IP addresses of the packets so as to output a multiplexed signal as a POS signal, and demultiplexes an input POS signal into packets on the basis of IP addresses of the packets;

an interface which is connected to said subscriber multiplexing/demultiplexing apparatus and transmits a POS signal; and

a protocol termination apparatus which includes a first interface block for interfacing with a backbone network, second and third interface blocks connected to said interface to interface a multiplexed signal with said subscriber multiplexing/demultiplexing apparatus, switching means, and PPP processing means,

wherein when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a data packet, said protocol termination apparatus causes said switching means to switch so as to transfer the data packet to said first interface block on the basis of an IP address of the data packet, and transmits the packet to the backbone network upon converting the packet into a POS signal by using said first interface block,

when a packet in a POS signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a control packet, said protocol termination apparatus causes said switching means to switch so as to transfer the control packet to said PPP processing means on the basis of an IP address of the control packet, and causes said PPP

processing means to transmit the received control packet through said third interface block and perform first PPP processing as PPP processing between said subscriber apparatuses through said subscriber multiplexing/demultiplexing apparatus, and

said protocol termination apparatus transmits a control packet through said second interface block to perform second PPP processing as PPP processing between said protocol termination apparatus and said subscriber multiplexing/demultiplexing apparatus.

[Claim 15] A system according to claim 14, wherein the packet processed by said subscriber apparatus and the packets multiplexed by said subscriber multiplexing/demultiplexing apparatus are Ethernet frame packets or IEEE 802.3 frame packets, and the packets demultiplexed by said subscriber multiplexing/demultiplexing apparatus and the packet processed by said protocol termination apparatus are PPP packets in PPP packet in PPP packets in an SDH/SONET frame transmitted over a POS signal.

[Claim 16] A system according to claim 14, wherein each of the packet processed by said subscriber apparatus and the packets multiplexed by said subscriber multiplexing/demultiplexing apparatus is a packet selected from the group consisting of an Ethernet packet, an IEEE 802.3 packet, and a PPP packet in the packet, and Ethernet frame packets or IEEE 802.3 frame packets, the packets demultiplexed by said subscriber multiplexing/demultiplexing apparatus and the packet processed by said protocol termination apparatus are PPP packets in PPP packet in PPP packets in an SDH/SONET frame transmitted over a POS signal.

[Claim 17] A multiplexing/demultiplexing apparatus which is connected to each communication signal transmitting section, multiplexes communication signals received from said communication signal transmitting sections, transmits a multiplexed signal to a multiplexed signal receiving section, demultiplexes a multiplexed signal received from said multiplexed signal transmitting section, and transmits demultiplexed communication signals to a communication signal receiving section, comprising:

first address extracting means for extracting an identification address, for each of the communication signals, which is added to a communication signal received from each of said communication signal transmitting sections and preassigned to a predetermined signal identifying section through which the communication signal passes in a multiplexing system including said communication signal transmitting section and said multiplexed signal receiving section;

multiplexing means for multiplexing the received communication signals on the basis of the identification address of each of the communication signals which is extracted by said first address extracting means, and transmitting the multiplexed signal to said multiplexed signal receiving section;

second address extracting means for extracting an identification address, for each of the communication signals, which is added to each of the communication signals in the multiplexed signal received from said multiplexed signal transmitting section and preassigned to a predetermined signal identifying section through which a communication signal passes in a demultiplexing

system including said multiplexed signal transmitting section and said communication signal receiving section; and

demultiplexing means for demultiplexing the multiplexed signal into the respective communication signals on the basis of the identification addresses of the respective communication signals which are extracted by said second address extracting means, and transmitting demultiplexed communication signals to said communication signal receiving section.

[Claim 18] An apparatus according to claim 17, wherein the communication signal is one of an Ethernet frame packet and an IEEE 802.3 frame packet, and the identification address supplied from said first address extracting means to said multiplex means is a MAC address.

[Claim 19] An apparatus according to claim 17, wherein the communication signal is a PPP packet in an Ethernet frame packet or an IEEE 802.3 frame packet, and the identification address supplied from said first address extracting means to said multiplex means is a MAC address.

[Claim 20] A multiplexing/demultiplexing apparatus including first receiving means provided for each subscriber apparatus and connected to a first communication path through which a packet output from said subscriber apparatus is transmitted, first transmitting means for transmitting a multiplexed signal to a first multiplex communication path, second receiving means connected to a second multiplex communication path through which a POS signal obtained by multiplexing packets addressed to said respective

subscriber apparatuses is transmitted, and second transmitting means for transmitting each demultiplexed packet to a corresponding second communication path, comprising:

first address extracting means, connected to said first receiving means, for extracting a MAC address of each of the packets which is added to a packet received by said first receiving means;

multiplexing means for multiplexing the packets received by said respective first receiving means on the basis of the MAC addresses of the respective packets which are extracted by said first address extracting means, and outputting the packet;

second address extracting means, connected to said second receiving means, for extracting IP addresses of the respective packets from the packets in the POS signal received through said second receiving means; and

demultiplexing means for demultiplexing each packet in the POS signal into the packets for said respective subscriber apparatuses on the basis of the IP addresses of the respective packets which are extracted by said second address extracting means, and outputting the packets to said second transmitting means.

[Claim 21] An apparatus according to claim 20, wherein the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet.

[Claim 22] An apparatus according to claim 20, wherein the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet.

[Claim 23] A protocol termination apparatus including a first interface block which

converts a data packet into a POS signal and transmits the signal to a backbone network, a second interface block which is connected to a subscriber multiplexing/demultiplexing apparatus to which a subscriber apparatus is connected, and receives a transmitted multiplexed signal obtained by causing said subscriber multiplexing/demultiplexing apparatus to multiplexed signals which serve to transmit packets created for the respective subscriber apparatuses and are received from the subscriber apparatuses, and a third interface block connected to said subscriber multiplexing/demultiplexing apparatus, comprising:

said second interface block which extracts the packet and the MAC address added to the packet or an IP address of the packet from the multiplexed signal;

PPP processing means which is connected to said subscriber multiplexing/demultiplexing apparatus through said third interface block and performs PPP processing between the subscriber apparatuses through said subscriber multiplexing/demultiplexing apparatus; and

switching means for, when a packet extracted by said second interface block is a data packet, transferring the data packet to said first interface block on the basis of the MAC address or the IP address of the packet which is extracted by said second interface block, and when a packet extracted by said second interface block is a control packet, transferring the control packet to said PPP processing means on the basis of one of the MAC address and the IP address of the packet which are extracted by said second interface block.

[Claim 24] An apparatus according to claim 23, wherein the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet.

[Claim 25] An apparatus according to claim 23, wherein the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet.

[Claim 26] A protocol termination apparatus including a first interface block which converts a packet into a POS signal and transmits the signal to a backbone network, a second interface block which is connected, through an interface, to a subscriber multiplexing/demultiplexing apparatus to which a subscriber apparatus is connected, and receives a transmitted multiplexed signal obtained by causing said subscriber multiplexing/demultiplexing apparatus, which has received signals, from the respective subscriber apparatuses, which are used to transmit packets created by the respective subscriber apparatuses, to multiplex the packets, and a third interface block connected to said subscriber multiplexing/demultiplexing apparatus, said interface being a interface which transmits a POS signal, comprising:

said second interface block which extracts a packet in the POS signal and an IP address of the packet;

PPP processing means, connected to said subscriber multiplexing/demultiplexing apparatus through said third interface block, for transmitting a control packet through said third interface block to perform first PPP processing as PPP processing between the subscriber apparatuses through said subscriber

Docket No. No. P14979-A
(YAM.046)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Yoshitaka FUJITA

Serial No.: 10/050,600 Group Art Unit: 2616

Filed: January 18, 2002 Examiner: Shand, Roberta A.

For: MULTIPLEXING METHOD AND APPARATUS, DEMULTIPLEXING METHOD AND APPARATUS, AND ACCESS NETWORK SYSTEM

Honorable Commissioner of Patents
Alexandria, VA 22313-1450

SUBMISSION OF VERIFIED ENGLISH TRANSLATION OF PRIORITY DOCUMENT AND DECLARATION UNDER 37 C.F.R. § 1.131

Sir:

In response to the Office Action dated March 29, 2006, and further to the Amendment under 37 C.F.R. § 1.111 filed on July 28, 2006, please enter and consider the following remarks:

INTRODUCTORY COMMENTS

Remarks begin on page 2 of this paper.

An **Appendix/Attachment** including:

Appendix A - executed Declaration under 37 C.F.R. § 1.131, including Exhibits 1-4); and

Appendix B - verified English Translation of the Priority document,

are attached following page 3 of this paper.

REMARKS

Claims 1-27 are all the claims presently pending in the application.

Applicant gratefully acknowledges that **claims 11-16 and 23-27** are **allowed**.

Claims 1, 3, 5, 6, 8, 10, and 17-20 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Mesh (U.S. Publication No. 2002/0085591A1). Claims 2, 4, 7, 9, 18, 19, 21, and 22 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Mesh in view of Baum (U.S. Patent No. 6,904,054).

Applicant reiterates that the Mesh reference can be removed as prior art by perfecting the claim to foreign priority and filing a Declaration under 37 C.F.R. § 1.131 showing invention of the subject matter of the present application prior to the filing date of the Mesh reference.

The Mesh reference was filed in the U.S. on **January 3, 2001**, prior to the present application's filing date, and published as a U.S. Patent Application Publication on **July 4, 2002**, after the present application's filing date. Thus, Mesh is available as prior art only under 35 U.S.C. § 102(e) as of its U.S. filing date of **January 3, 2001**.

Therefore, the Mesh reference can be removed as prior art by perfecting Applicant's claim to foreign priority based on JP 2001-012997, which was filed on **January 22, 2001**, and filing a declaration under 37 C.F.R. § 1.131 which swears behind the **January 3, 2001** filing date of the Mesh reference, by establishing invention of the subject matter of the present application before the **January 3, 2001** filing date of Mesh.

An executed Declaration under 37 C.F.R. § 1.131 and corresponding Exhibits 1-4 (and English translations thereof) are submitted concurrently herewith in the attached Appendix.

A verified English translation of the foreign priority document also is submitted concurrently herewith in the attached Appendix, thereby perfecting Applicant's claim to foreign priority.

For the foregoing reasons, the Mesh reference should be removed as prior art and the Examiner is requested to withdraw these rejections and to permit claims 1-10 and 17-22 to pass to immediate allowance.

CONCLUSION

In view of the foregoing, Applicant submits that claims 1-27, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: August 11, 2006

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multiplexing/demultiplexing apparatus, and transmitting the control packet through said third interface block to perform second PPP processing as PPP processing with said subscriber multiplexing/demultiplexing apparatus; and

switching means for, when a packet extracted by said second interface block is a data packet, transferring the data packet to said first interface block on the basis of the IP address extracted by said second interface block, and when a packet extracted by said second interface block is a control packet, transferring the control packet to said PPP processing means on the basis of the IP address extracted by said second interface block.

[Claim 27] An apparatus according to claim 26, wherein the packet is a PPP packet in a PPP packet in PPP packet in an SDH/SONET frame transmitted over an POS signal.

[Detailed Description of the Invention]

[0001]

The present invention relates to a multiplexing method and apparatus, demultiplexing method and apparatus, access network system, subscriber multiplexing/demultiplexing apparatus, and protocol termination apparatus, which multiplex PPP packets on the basis of MAC addresses and the like, demultiplex the packets on the basis of IP addresses, and simplify an arrangement required for PPP processing by using these multiplexing and demultiplexing processes.

[0002]

[Background Art]

Conventionally, in the Internet, prior to data

communication upon forming a communication path between two terminals connected to the Internet, the terminals must be connected to a backbone network through an access network. For this connection, the Point-to-Point Protocol (PPP) is used.

[0003]

An outline of PPP in an access network will be described first.

In connection to the Internet, each subscriber must terminate PPP for transferring an IP (Internet Protocol) packet in response to an Internet access request. PPP serves to perform authentication, accounting, service management system (SMS) operation, subscriber-specific band allocation, and the like. Any subscriber who is not authenticated/registered cannot form a link itself, and hence can neither transfer data nor receive an IP address itself. Accounting corresponds to a connection time.

[0004]

PPP is also used in an Internet backbone network. Unlike PPP used in the access network, this PPP serves to, for example, determine a maximum packet length: MTU (Maximum Transfer Unit) size of packets to be exchanged between the backbone network and the access network.

In order to transmit IP data to the backbone network through the access network connected to the backbone network, PPP termination must be performed in each access network. Conventionally, PPP termination is performed at an entrance to an ISP (Internet Service Provider). PPP termination itself has been handled in the conventional access network systems by installing

dedicated units (Fig. 19).

[0005]

The conventional access network system shown in Fig. 19 is comprised of an ATU (Address Transformation Unit)-R 201, DSLAM (Digital Subscriber Line Access Multiplexer) 30m, ATM SW (Asynchronous Transfer Mode Switch) 40n, and PPP termination apparatus 501. A PC (Personal Computer) 10k is connected to the ATU-R 201. Note that 1 of 201 suffixed to ATU-R indicates that there are 1 to P ATU-Rs, m of 30m suffixed to DSLAM indicates that there are 1 to Q DSLAMs, and n of 40n suffixed to ATM SW indicates that there are 1 to R ATM SWs. Reference numeral 4101 denotes an ADSL (Asynchronous Digital Subscriber Line)/VDSL (Very high speed Digital Subscriber Line); 5101, an ATM OC-3c interface; and 6101, an ATM OC-12c interface.

[0006]

PPP is a protocol for supporting data transfer using a multiprotocol through a communication path between the ATU-R 201 and PPP termination apparatus 501 of the access network system. When PPP processing starts, an LCP (Link Control Protocol) packet of the PPP control packets shown in Fig. 22 is transmitted as a PPP packet transmitted from the ATU-R 201 to the PPP termination apparatus 501. Whether a given packet is an LCP packet is determined depending on whether the value in the protocol field in the PPP packet is c021. A link is established on the basis of this LCP packet. A user is authenticated concerning the established link.

[0007]

An NCP (Network Control Protocol) packet is then transmitted, and IP address distribution processing

and the like for data transfer to an upper layer are performed on the basis of this NCP packet. Whether a given packet is an NCP packet is determined depending on whether the value in the protocol field in the PPP packet is 8021.

Transfer of an IP packet in which user packet data is inserted is started on the basis of the IP address distributed to the established and authenticated link afterward. The above description is based on the IETF (Internet Engineering Task Force) Documents RFC 1161/1162/1332.

[0008]

As a frame format used for PPP processing, an HDLC (High Data Link Control Procedure) frame configuration is used. A 32-bit protocol field is added first to the payload of this frame configuration, and then an IP packet is inserted as packet data in the configuration, thereby forming an overall PPP packet.

[0009]

The above link establishment processing will be described in detail to some extent.

A link protocol for performing link establishment processing before transmission of an IP packet is subordinate to the IP layer (Fig. 20).

As shown in Fig. 22, in link establishment processing, when an Internet access request is generated, control on the link unusing phase advances to the link establishment phase and moves to the authentication phase. The processing so far corresponds to LCP setting in Fig. 23.

When the processing in the authentication phase is properly performed, control is transferred to

the NCP phase to perform the above IP address distribution processing and the like. With this operation, a link is established. This processing corresponds to NCP setting in Fig. 23.

[0010]

After this link establishment processing, transfer of the above IP packet is started. The IP packet is contained in a PPP packet, and the resultant PPP packet is transmitted. With this operation, the IP packet is transmitted. Whether the PPP packet is a PPP data packet is determined depending on whether the value in the protocol field is 0021.

[0011]

As described above, in both link establishment and IP packet transmission, each PPP packet to be transmitted is created upon addition of a PPP header thereto on the PPP layer of the ATU-R 201. In addition, this packet is formed into an ATM cell on the AAL5 (ATM Adaptation Layer Type 5) layer and transmitted to the DSLAM 30m through the PHY layer (Fig. 20).

[0012]

The DSLAM 30m which receives the ATM cell also performs predetermined processing, on the ATML5 layer, for the ATM cell input through the PHY layer. Similar processing is performed in the ATM SW 40n and PPP termination apparatus 501 (Fig. 20).

[0013]

If, therefore, an overall access network system is formed by using the AAL5 layer (Fig. 20), since the PPP frame whose ATM cell has been subjected frame header addition processing (PPP Encapsulation) is transmitted, SAR (Segmentation and Reassembly Sublayer)

on the AAL5 layer must be performed first to terminate PPP. With this SAR processing, an original PPP frame is reassembled or processing for link establishment is performed by the CPU of the PPP termination apparatus 501. After link establishment, the subscriber can transfer the IP packet to a backbone network 601.

[0014]

[Problem to be Solved by the Invention]

The following problems, however, arise in the prior art described above.

In the prior art, as described above, an apparatus (the PPP termination apparatus 501 in Fig. 19) which discriminates each subscriber who tries to access the Internet and has a function for ATM processing must be installed at an entrance to the backbone network 601. Such an apparatus must be added every time the number of subscribers increases. In addition, the PPP termination apparatus 501 is often installed near the backbone network 601 to which packets from many subscribers are sent upon multiplexing.

According to the access network system like the one shown in Fig. 19, since the overall access network system is formed by using the AAL5 layer, the overall system inevitably becomes complicated.

[0015]

As the number of subscribers who access the Internet increases, an apparatus for performing PPP processing as processing indispensable to connection of the subscribers to the backbone network of the Internet must be added. Such an apparatus may be installed in a place as near to the subscribers as possible, i.e., in an apparatus for providing Internet services (e.g., the

ATM SW 40n in Fig. 19). In this case, it is required to avoid complication of PPP, complication of its system, complication of a management system for the system, and the like.

[0016]

The present invention has been made in consideration of the above situation, and has as its object to provide a multiplexing method and apparatus, demultiplexing method and apparatus, access network system, subscriber multiplexing/demultiplexing apparatus, and protocol termination apparatus which can multiplex PPP packets on the basis of MAC addresses and the like, demultiplex the packets on the basis of MAC or IP addresses, and simplify an arrangement for PPP processing by using these multiplexing and demultiplexing processes.

[0017]

[Means of Solution to the Problem]

In order to achieve the above object, according to the present invention, there is provided a multiplexing method of multiplexing communication signals from communication signal transmitting sections and transmitting a multiplexed signal to a multiplexed signal receiving section, comprising the steps of adding, to each of the communication signals, an identification address preassigned to a predetermined signal identifying section through which a communication signal passes in a multiplexing system including the communication signal transmitting section and the multiplexed signal receiving section and outputting each of the communication signals, extracting the identification address from each output signal, and

multiplexing the respective communication signals on the basis of the extracted identification addresses.

[0018]

According to the invention of claim 2, in the multiplexing method of claim 1, the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[0019]

According to the invention of claim 3, a demultiplexing method of receiving a multiplexed signal obtained by multiplexing a plurality of communication signals from a multiplexed signal transmitting section, demultiplexing the signal into communication signals, and transmitting the demultiplexed communication signal to a communication signal receiving section, comprising the steps of adding, to each of the communication signals, an identification address preassigned to a predetermined signal identifying section through which a communication signal passes in a multiplexing system including the multiplexed signal transmitting section and the communication signal receiving section, and outputting each of the communication signals, extracting the identification address from the output signal, and demultiplexing the multiplexed signal for each of the communication signals on the basis of the extracted identification address.

[0020]

According to the invention of claim 4, in the multiplexing method of claim 3, the communication signal is a PPP packet created for each Internet subscriber

apparatus, and the identification address is a MAC address.

[0021]

According to the invention of claim 5, a demultiplexing method of demultiplexing a multiplexed signal obtained by multiplexing a plurality of packet into packets, comprising the steps of extracting an IP address from each packet in the received multiplexed signal, and demultiplexing the multiplexed signal into PPP packets on the basis of the extracted IP addresses.

[0022]

According to the invention of claim 6, a multiplexing apparatus which is connected to communication paths of communication signal transmitting sections, multiplexes communication signals from the communication paths, and transmits a multiplexed signal to a multiplexed signal receiving section through a multiplex communication path, comprising address extracting means for extracting an identification address, for each communication signal, which is added to the communication signal received from each of the communication paths and preassigned to a predetermined signal identifying section through which the communication signal passes in a multiplexing system including the communication signal transmitting section and the multiplexed signal receiving section, and multiplexing means for multiplexing the communication signals received from the respective communication paths on the basis of the identification addresses set for the respective communication signals extracted by said address extracting means.

[0023]

According to the invention of claim 7, in the multiplexing apparatus of claim 6, the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[0024]

According to the invention of claim 8, a demultiplexing apparatus which is connected to a multiplexed signal transmitting section through a multiplex communication path, demultiplexes a multiplexed signal received from the multiplex communication path, and transmits demultiplexed communication signals to a communication signal receiving section through communication paths for the respective communication signals, comprising address extracting means, connected to the multiplex communication path, for extracting an identification address, for each of the communication signals, which is added to each of the communication signals in the multiplexed signal received from the multiplex communication path and preassigned to a predetermined signal identifying section through which a communication signal passes in a demultiplexing section including said multiplexed signal transmitting section and said communication signal receiving section, and demultiplexing means for demultiplexing the multiplexed signal into the respective communication signals on the basis of the identification addresses of the respective communication signals which are extracted by said address extracting means.

[0025]

According to the invention of claim 9, in the

multiplexing apparatus of claim 8, the communication signal is a PPP packet created for each Internet subscriber apparatus, and the identification address is a MAC address.

[0026]

According to the invention of claim 10, a demultiplexing apparatus which is connected to a multiplex communication path through which a multiplexed signal obtained by multiplexing packets addressed to subscriber apparatuses is transmitted, demultiplexes the multiplexed signal received from the multiplex communication path, and outputs each demultiplexed communication signal, comprising address extracting means, connected to the multiplex communication path, for extracting an IP address of each packet in the multiplexed signal received from the multiplex communication path, and demultiplexing means for demultiplexing the multiplexed signal into the respective packets on the basis of the IP addresses of the respective packets extracted by said address extracting means.

[0027]

According to the invention of claim 11, an access network system comprising a plurality of subscriber apparatuses which transmit/receive one of a signal having a MAC address added to a packet and a signal having no MAC address added to a packet, a subscriber multiplexing/demultiplexing apparatus which multiplexes packets in signals transmitted from said respective subscriber apparatuses on the basis of MAC addresses added to the packets or IP addresses of the packets, and demultiplexes an input multiplexed signal

into packets on the basis of one of a MAC address added to each packet and an IP address of each packet, and a protocol termination apparatus which includes a first interface block which interfaces with a backbone network, second and third interface blocks which interface a multiplexed signal with said subscriber multiplexing/demultiplexing apparatus, switching means, and PPP processing means, wherein when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a data packet, said protocol termination apparatus causes said switching means to switch to transfer the data packet to said first interface block on the basis of one of a MAC address added to the data packet and an IP address of the packet, and transmits the packet to a backbone network upon converting the packet into a POS signal by using said first interface block, and when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a control packet, said protocol termination apparatus causes said switching means to switch to transfer the control packet to said PPP processing means on the basis of one of a MAC address added to the control packet and an IP address of the packet, and causes said PPP processing means to transmit the received control packet through said third interface block and perform PPP processing with said subscriber apparatus through said subscriber multiplexing/demultiplexing apparatus.

[0028]

According to the invention of claim 12, in the

access network system of claim 11, the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet, the data packet is one of a PPP data packet in the Ethernet frame packet and a PPP data packet in the IEEE 802.3 frame, and the control packet is one of a PPP control packet in the Ethernet packet and a PPP control packet in the IEEE 802.3 frame.

[0029]

According to the invention of claim 13, in the access network system of claim 11, the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet, the data packet is one of a PPP data packet in the Ethernet frame packet and a PPP data packet in the IEEE 802.3 frame, and the control packet is one of a PPP control packet in the Ethernet packet and a PPP control packet in the IEEE 802.3 frame.

[0030]

According to the invention of claim 14, an access network system comprising a plurality of subscriber apparatuses which transmit/receive one of a signal having a MAC address added to a packet and a signal having no MAC address added to a packet, a subscriber multiplexing/demultiplexing apparatus which multiplexes packets in signals transmitted from said respective subscriber apparatuses on the basis of MAC addresses added to the packets or IP addresses of the packets so as to output a multiplexed signal as a POS signal, and demultiplexes an input POS signal into packets on the basis of IP addresses of the packets, an interface which is connected to said subscriber multiplexing/demultiplexing apparatus and transmits a

POS signal, and a protocol termination apparatus which includes a first interface block for interfacing with a backbone network, second and third interface blocks connected to said interface to interface a multiplexed signal with said subscriber multiplexing/demultiplexing apparatus, switching means, and PPP processing means, wherein when a packet in a multiplexed signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a data packet, said protocol termination apparatus causes said switching means to switch so as to transfer the data packet to said first interface block on the basis of an IP address of the data packet, and transmits the packet to the backbone network upon converting the packet into a POS signal by using said first interface block, when a packet in a POS signal received from said subscriber multiplexing/demultiplexing apparatus through said second interface block is a control packet, said protocol termination apparatus causes said switching means to switch so as to transfer the control packet to said PPP processing means on the basis of an IP address of the control packet, and causes said PPP processing means to transmit the received control packet through said third interface block and perform first PPP processing as PPP processing between said subscriber apparatuses through said subscriber multiplexing/demultiplexing apparatus, and said protocol termination apparatus transmits a control packet through said second interface block to perform second PPP processing as PPP processing between said protocol termination apparatus and said subscriber multiplexing/demultiplexing apparatus.

[0031]

According to the invention of claim 15, in the access network system of claim 14, the packet processed by said subscriber apparatus and the packets multiplexed by said subscriber multiplexing/demultiplexing apparatus are Ethernet frame packets or IEEE 802.3 frame packets, and the packets demultiplexed by said subscriber multiplexing/demultiplexing apparatus and the packet processed by said protocol termination apparatus are PPP packets in PPP packet in PPP packets in an SDH/SONET frame transmitted over a POS signal.

[0032]

According to the invention of claim 16, in the access network system of claim 14, each of the packet processed by said subscriber apparatus and the packets multiplexed by said subscriber multiplexing/demultiplexing apparatus is a packet selected from the group consisting of an Ethernet packet, an IEEE 802.3 packet, and a PPP packet in the packet, and Ethernet frame packets or IEEE 802.3 frame packets, the packets demultiplexed by said subscriber multiplexing/demultiplexing apparatus and the packet processed by said protocol termination apparatus are PPP packets in PPP packet in PPP packets in an SDH/SONET frame transmitted over a POS signal.

[0033]

According to the invention of claim 17, a multiplexing/demultiplexing apparatus which is connected to each communication signal transmitting section, multiplexes communication signals received from said communication signal transmitting sections, transmits a multiplexed signal to a multiplexed signal receiving

section, demultiplexes a multiplexed signal received from said multiplexed signal transmitting section, and transmits demultiplexed communication signals to a communication signal receiving section, comprising first address extracting means for extracting an identification address, for each of the communication signals, which is added to a communication signal received from each of said communication signal transmitting sections and preassigned to a predetermined signal identifying section through which the communication signal passes in a multiplexing system including said communication signal transmitting section and said multiplexed signal receiving section, multiplexing means for multiplexing the received communication signals on the basis of the identification address of each of the communication signals which is extracted by said first address extracting means, and transmitting the multiplexed signal to said multiplexed signal receiving section, second address extracting means for extracting an identification address, for each of the communication signals, which is added to each of the communication signals in the multiplexed signal received from said multiplexed signal transmitting section and preassigned to a predetermined signal identifying section through which a communication signal passes in a demultiplexing system including said multiplexed signal transmitting section and said communication signal receiving section, and demultiplexing means for demultiplexing the multiplexed signal into the respective communication signals on the basis of the identification addresses of the respective communication signals which are extracted by said second

address extracting means, and transmitting demultiplexed communication signals to said communication signal receiving section.

[0034]

According to the invention of claim 18, in the multiplexing/demultiplexing apparatus of claim 17, the communication signal is one of an Ethernet frame packet and an IEEE 802.3 frame packet, and the identification address supplied from said first address extracting means to said multiplex means is a MAC address.

[0035]

According to the invention of claim 19, in the multiplexing/demultiplexing apparatus of claim 17, the communication signal is a PPP packet in an Ethernet frame packet or an IEEE 802.3 frame packet, and the identification address supplied from said first address extracting means to said multiplex means is a MAC address.

[0036]

According to the invention of claim 20, a multiplexing/demultiplexing apparatus including first receiving means provided for each subscriber apparatus and connected to a first communication path through which a packet output from said subscriber apparatus is transmitted, first transmitting means for transmitting a multiplexed signal to a first multiplex communication path, second receiving means connected to a second multiplex communication path through which a POS signal obtained by multiplexing packets addressed to said respective subscriber apparatuses is transmitted, and second transmitting means for transmitting each demultiplexed packet to a corresponding second

communication path, comprising first address extracting means, connected to said first receiving means, for extracting a MAC address of each of the packets which is added to a packet received by said first receiving means, multiplexing means for multiplexing the packets received by said respective first receiving means on the basis of the MAC addresses of the respective packets which are extracted by said first address extracting means, and outputting the packet, second address extracting means, connected to said second receiving means, for extracting IP addresses of the respective packets from the packets in the POS signal received through said second receiving means, and demultiplexing means for demultiplexing each packet in the POS signal into the packets for said respective subscriber apparatuses on the basis of the IP addresses of the respective packets which are extracted by said second address extracting means, and outputting the packets to said second transmitting means.

[0037]

According to the invention of claim 21, in the multiplexing/demultiplexing apparatus of claim 20, an apparatus according to claim 20, wherein the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet.

[0038]

According to the invention of claim 22, in the multiplexing/demultiplexing apparatus of claim 20, an apparatus according to claim 20, wherein the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet.

[0039]

According to the invention of claim 23, a

protocol termination apparatus including a first interface block which converts a data packet into a POS signal and transmits the signal to a backbone network, a second interface block which is connected to a subscriber multiplexing/demultiplexing apparatus to which a subscriber apparatus is connected, and receives a transmitted multiplexed signal obtained by causing said subscriber multiplexing/demultiplexing apparatus to multiplexed signals which serve to transmit packets created for the respective subscriber apparatuses and are received from the subscriber apparatuses, and a third interface block connected to said subscriber multiplexing/demultiplexing apparatus, comprising said second interface block which extracts the packet and the MAC address added to the packet or an IP address of the packet from the multiplexed signal, PPP processing means which is connected to said subscriber multiplexing/demultiplexing apparatus through said third interface block and performs PPP processing between the subscriber apparatuses through said subscriber multiplexing/demultiplexing apparatus, and switching means for, when a packet extracted by said second interface block is a data packet, transferring the data packet to said first interface block on the basis of the MAC address or the IP address of the packet which is extracted by said second interface block, and when a packet extracted by said second interface block is a control packet, transferring the control packet to said PPP processing means on the basis of one of the MAC address and the IP address of the packet which are extracted by said second interface block.

[0040]

According to the invention of claim 24, in the protocol termination apparatus of claim 23, the packet is one of an Ethernet frame packet and an IEEE 802.3 frame packet.

[0041]

According to the invention of claim 25, in the protocol termination apparatus of claim 23, the packet is one of a PPP packet in an Ethernet frame packet and a PPP packet in an IEEE 802.3 frame packet.

[0042]

According to the invention of claim 26, a protocol termination apparatus including a first interface block which converts a packet into a POS signal and transmits the signal to a backbone network, a second interface block which is connected, through an interface, to a subscriber multiplexing/demultiplexing apparatus to which a subscriber apparatus is connected, and receives a transmitted multiplexed signal obtained by causing said subscriber multiplexing/demultiplexing apparatus, which has received signals, from the respective subscriber apparatuses, which are used to transmit packets created by the respective subscriber apparatuses, to multiplex the packets, and a third interface block connected to said subscriber multiplexing/demultiplexing apparatus, said interface being a interface which transmits a POS signal, comprising said second interface block which extracts a packet in the POS signal and an IP address of the packet, PPP processing means, connected to said subscriber multiplexing/demultiplexing apparatus through said third interface block, for transmitting a control packet through said third interface block to perform first PPP

processing as PPP processing between the subscriber apparatuses through said subscriber multiplexing/demultiplexing apparatus, and transmitting the control packet through said third interface block to perform second PPP processing as PPP processing with said subscriber multiplexing/demultiplexing apparatus, and switching means for, when a packet extracted by said second interface block is a data packet, transferring the data packet to said first interface block on the basis of the IP address extracted by said second interface block, and when a packet extracted by said second interface block is a control packet, transferring the control packet to said PPP processing means on the basis of the IP address extracted by said second interface block.

[0043]

According to the invention of claim 27, in the protocol termination apparatus of claim 26, the packet is a PPP packet in a PPP packet in PPP packet in an SDH/SONET frame transmitted over an POS signal.

[0044]

[Mode of Carrying Out the Invention]

The present invention will be described in detail below with reference to the accompanying drawings.

◇ First Embodiment

Fig. 1 is a block diagram showing the electrical arrangement of an access network system according to the first embodiment of the present invention; Fig. 2 is a block diagram showing the flow of a PPP control packet in the detailed arrangement of the access network system; Fig. 3 is a block diagram showing the flow of a PPP data packet in the detailed

arrangement of the access network system; Fig. 4 is a block diagram showing an example of how MAC addresses are assigned to the subscriber apparatus, subscriber multiplexing/demultiplexing apparatus, and access gateway shown in Figs. 2 and 3; Fig. 5 is a view showing a protocol stack; Fig. 6 is a block diagram schematically showing the functions of the ADSL/VDSL interface block, multiplexing clock, and Ethernet/IEEE 802.3 interface block shown in Fig. 2; Fig. 7 is a view showing the process of upward multiplexing in the subscriber multiplexing/demultiplexing apparatus; Fig. 8 is a block diagram schematically showing the functions of the Ethernet/IEEE 802.3 interface block, demultiplexing block, and ADSL/VDSL interface block shown in Fig. 2; Fig. 9 is a view showing the process of downward multiplexing in the subscriber multiplexing/demultiplexing apparatus; Fig. 10 is a schematic view showing how queue write and queue read in the upward direction are performed in the packet switch module shown in Figs. 2 and 3; Fig. 11 is a schematic view showing how queue write and queue read in the downward direction are performed in the packet switch module shown in Figs. 2 and 3; Figs. 12A and 12B are views respectively showing the format of a PPP packet and the format of an Ethernet/IEEE 802.3 frame; Fig. 13 is a view showing the difference between the format of an Ethernet frame and the format of an IEEE 802.3 frame; Fig. 14 is a view showing the format of an IP packet;

[0045]

An access network system 10 according to this embodiment is a system for performing PPP processing by using the MAC layer and roughly comprised of a

subscriber apparatus (ATUU-R) 2nm, subscriber multiplexing/demultiplexing apparatus (DSLAM) 4n, and an access gateway (AG) 61, as shown in Fig. 1. A personal computer 1nm1 is connected to the subscriber apparatus 2nm of this system and designed as a whole such that Internet communication can be performed by connecting a backbone network 81 to the access gateway 61 through a POS OC-12C interface 71. POS of the POS OC-12C interface 71 is an abbreviation for packet over SDH/SONET (Synchronous Digital Dierachy/Synchronous Optical Network), and OC-12 stands for a communication speed, which is 620 Mb/s.

[0046]

Note that n of reference numeral 4n of the DSLAM 4n indicates that a predetermined number of subscriber multiplexing/demultiplexing apparatuses, i.e., 1 to N subscriber multiplexing/demultiplexing apparatuses, are connected to the access gateway 61.

In addition, m of reference numeral 2nm of the subscriber apparatus 2nm indicates that a predetermined number of subscriber apparatuses, i.e., 1 to M subscriber apparatuses, which is equal to or different from n, are connected to the subscriber multiplexing/demultiplexing apparatuses 4n, respectively.

Furthermore, 1 of reference numeral 1nm1 of the personal computer 1nm1 indicates that a predetermined number of personal computers, i.e., 1 to 1 personal computers, which is equal to or different from m, are connected to the subscriber apparatuses 2nm, respectively. Fig. 14 shows the format of an IP packet. The abbreviations in Fig. 14 are known notations.

[0047]

The personal computer 1nml is an Internet terminal apparatus, which designed to output an IP (Internet Protocol) packet to the subscriber apparatus ATU (Address Transformation Unit)-R 2nm.

The subscriber apparatus 2nm adds a PPP (Point-to-Point Protocol) header (PPP of ATUU-R in Fig. 5) to the IP packet transmitted from the personal computer 1nml, and then adds the frame header of an Ethernet/IEEE 802.3 frame (MAC of ATUU-R in Fig. 5) to form an Ethernet/IEEE 802.3 frame packet. In this case, the Ethernet/IEEE 802.3 frame is a frame on which the PPP packet formed by adding a PPP header to an IP packet is set. This frame may be an Ethernet frame or IEEE 802.3 frame. Fig. 13 shows the formats of an Ethernet frame and IEEE 802.3 frame. The abbreviations in Fig. 13 are known notations.

[0048]

The subscriber apparatus 2nm performs analog modulation of a signal on which an Ethernet/IEEE 802.3 frame packet having the frame header of an Ethernet/IEEE 802.3 frame added thereto is carried. With this operation, the signal is converted into a 100-Kb/s ADSL/VDSL signal and output. In this case, the ADSL/VDSL signal has a signal form used for the transmission of an Ethernet/IEEE 802.3 frame packet. This indicates that either an ADSL signal or a VDSL signal may be used.

The above frame header contains a MAC address. This MAC address includes a source identification address (SRC MAC Address) (the identification address of a predetermined identification section through which a communication signal passes in the multiplex system) at

which a signal is output from the subscriber apparatus 2nm, and a predetermined destination identification address (DSC MAC Address) (the identification address of a signal identification section through which a communication signal passes in the multiplex system) at which a signal is input the subscriber multiplexing/demultiplexing apparatuses 4n. As a source identification address and destination identification address, the addresses of apparatuses from/to which signals are output/input or the addresses of the ports of apparatuses from/to which signals are output/input are used. These apparatuses or ports themselves correspond to the above signal identification section.

[0049]

An example of how a MAC address is added will be described below with reference to Fig. 4.

As shown in Fig. 4, as the MAC address (DST MAC Address/SRC MAC Address) to be added to the Ethernet/IEEE 802.3 frame output from the subscriber apparatus 2nm to the subscriber multiplexing/demultiplexing apparatus 4n, 2011/1021 is used. 2011 is a destination identification address for identifying the input port of the subscriber multiplexing/demultiplexing apparatus 4n, and 1021 is a source identification address for identifying the subscriber apparatus 2nm.

Since each port (ADSL/VDSL interface 3nmU) directed from the subscriber multiplexing/demultiplexing apparatus 4n to a corresponding one of subscriber apparatuses 2nm is connected to the subscriber apparatus 2nm in a one-to-one correspondence with each other, either 2011 or 1021 may be used as a MAC address. Since

a subscriber is specified in the subscriber multiplexing/demultiplexing apparatus 4n, either of these addresses can be selectively used as a MAC address in the subscriber multiplexing/demultiplexing apparatus 4n.

[0050]

The subscriber multiplexing/demultiplexing apparatuses 4n is comprised of an ADSL/VDSL interface block 4n1, multiplexing block 4n2, Ethernet/IEEE 802.3 interface block 4n3, Ethernet/IEEE 802.3 interface block 4n4, demultiplexing block 4n5, and ADSL/VDSL interface 4n6. In this case, the "ADSL/VDSL interface block" indicates that either an ADSL interface block or an VDSL interface block is used depending on whether an ADSL interface or a VDSL interface is used as an interface between the subscriber apparatus 2nm and the subscriber multiplexing/demultiplexing apparatuses 4n. In this case, the "Ethernet/IEEE 802.3 interface block" indicates that either an Ethernet interface block or an IEEE 802.3 interface block is used depending on whether an Ethernet interface or an IEEE 802.3 interface is used as an interface between the subscriber multiplexing/demultiplexing apparatuses 4n and the access gateway 61.

[0051]

The access gateway 61 is comprised of an Ethernet/IEEE 802.3 interface block 6nU, packet switch module 611, POS OC-12C interface block 612, POS OC-12C interface block 613, CPU board 614A, and Ethernet/IEEE 802.3 interface block 6nD. In this case, the "Ethernet/IEEE 802.3 interface block" indicates that either an Ethernet interface block or an IEEE 802.3

interface block is used depending on whether an Ethernet interface or an IEEE 802.3 interface is used as an interface between the subscriber multiplexing/demultiplexing apparatuses 4n and the access gateway 61.

[0052]

The constituent elements of the subscriber multiplexing/demultiplexing apparatuses 4n will be described in detail first.

The ADSL/VDSL interface block 4n1 is provided for each subscriber and executes an interface function with respect to an ADSL/VDSL signal input from the subscriber apparatus 2nm for a corresponding subscriber. That is, the ADSL/VDSL interface block 4n1 extracts an Ethernet/IEEE 802.3 frame packet and the MAC address added to the packet from a received ADSL/VDSL signal, and transfers the extracted Ethernet/IEEE 802.3 frame packet and MAC address to the multiplexing block 4n2.

[0053]

The multiplexing block 4n2 multiplexes the Ethernet/IEEE 802.3 frame packets input from the respective ADSL/VDSL interface blocks 4n1 by using a plurality of FIFOs. This multiplexing is performed on the basis of input MAC addresses.

The Ethernet/IEEE 802.3 interface block 4n3 executes an interface function between the subscriber multiplexing/demultiplexing apparatuses 4n and the access gateway 61. That is, the Ethernet/IEEE 802.3 interface block 4n3 converts a multiplexed Ethernet/IEEE 802.3 frame packet into an Ethernet/IEEE 802.3 signal and outputs it onto an Ethernet/IEEE 802.3 interface block 5nU.

[0054]

The Ethernet/IEEE 802.3 interface block 4n4 executes an interface function between the access gateway 61 and the subscriber multiplexing/demultiplexing apparatuses 4n. That is, the Ethernet/IEEE 802.3 interface block 4n4 receives the Ethernet/IEEE 802.3 signal output from the Ethernet/IEEE 802.3 interface block 6nD of the access gateway 61, extracts an Ethernet/IEEE 802.3 frame packet and MAC address, and transfers the extracted Ethernet/IEEE 802.3 frame packet and MAC address to the demultiplexing block 4n5.

The demultiplexing block 4n5 demultiplexes the Ethernet/IEEE 802.3 frame packet transferred from the Ethernet/IEEE 802.3 interface block 4n4 by using a plurality of FIFOs. This demultiplexing is performed on the basis of an input MAC address.

The ADSL/VDSL interface 4n6 is provided for each subscriber apparatus 2nm and executes an interface function with respect to each Ethernet/IEEE 802.3 frame packet demultiplexed by the demultiplexing block 4n5 for a corresponding subscriber. That is, the ADSL/VDSL interface 4n6 converts each demultiplexed Ethernet/IEEE 802.3 frame packet into an ADSL/VDSL signal and transfers it to a corresponding subscriber apparatus.

[0055]

The respective constituent elements of the access gateway 61 will be described in detail next.

The Ethernet/IEEE 802.3 interface block 6nU executes an interface function with respect to the Ethernet/IEEE 802.3 signal (the signal carrying an Ethernet/IEEE 802.3 frame packet) input from the

subscriber multiplexing/demultiplexing apparatuses 4n through the Ethernet/IEEE 802.3 interface block 5nU. That is, the Ethernet/IEEE 802.3 interface block 6nU receives an Ethernet/IEEE 802.3 signal, extracts an Ethernet/IEEE 802.3 frame packet and an MAC address contained in the packet, and transfers the extracted Ethernet/IEEE 802.3 frame packet and the MAC address in the packet to the packet switch module 611.

[0056]

The Ethernet/IEEE 802.3 interface block 6nU refers to the value indicated by the protocol field of a PPP packet in an extracted Ethernet/IEEE 802.3 frame packet and perform the first discrimination, i.e., discriminating the PPP packet extracted from the Ethernet/IEEE 802.3 signal as a PPP data packet if the value is "0021", and the second discrimination, i.e., discriminating the PPP packet extracted from the Ethernet/IEEE 802.3 signal as a PPP control packet if the value is "8021" or "c021". The Ethernet/IEEE 802.3 interface block 6nU then supplies the discrimination result to the packet switch module 611.

[0057]

The packet switch module 611 performs switching with respect to Ethernet/IEEE 802.3 frame packets on the basis of the MAC addresses and discrimination results transferred from the Ethernet/IEEE 802.3 interface block 6nU, and also performs switching with respect to PPP packets on the basis of the IP addresses transferred from the POS OC-12C interface block 613.

[0058]

The POS OC-12C interface block 612 executes an

interface function between the access gateway 61 and the backbone network 81. If the PPP packet in the Ethernet/IEEE 802.3 frame packet input to the packet switch module 611 is a PPP data packet, i.e., the discrimination result is the first discrimination, the PPP packet (Fig. 17A) is output through the POS OC-12C interface block 612. In this case, the PPP packet is subjected PPP termination processing, and the PPP packet having undergone the PPP termination processing is converted into a PPP packet in PPP packet (Fig. 17B shows its frame). The PPP packet in PPP packet is electrooptically converted into a POS signal (POS OC-12c signal) in the SDH/SONET frame form shown in Fig. 18. This signal is then transmitted to the backbone network 81 through the POS OC-12C interface 71.

[0059]

The POS OC-12C interface block 613 executes an interface function with respect to the POS signal received from the backbone network 81 through the POS OC-12C interface 71. That is, the POS OC-12C interface block 613 performs PPP termination processing (PPP termination processing between the backbone network 81 and the access gateway 61) with respect to a POS signal, i.e., extracts a PPP packet from the POS signal and adds a protocol field to the PPP packet (sets the value of the protocol field to 0021) to form a PPP packet. With this PPP termination processing, the POS signal is formed into a PPP packet and transferred to the packet switch module 611.

[0060]

The CPU board 614A performs transfer processing for the PPP control packet shown in Figs. 22

and 23 under program control on the basis of the second discrimination, and transfers the PPP control packet for necessary PPP processing between the CPU board 614A of the access gateway 61 and the subscriber apparatus 2nm.

[0061]

The Ethernet/IEEE 802.3 interface block 6nD receives the Ethernet/IEEE 802.3 frame packet or PPP packet switched by the packet switch module 611, and adds the frame header (containing a MAC address) of the Ethernet/IEEE 802.3 frame. The Ethernet/IEEE 802.3 interface block 6nD then converts the Ethernet/IEEE 802.3 frame packet into an Ethernet/IEEE 802.3 signal, and outputs it onto an Ethernet/IEEE 802.3 interface 5nD.

The MAC address to be added includes a source identification address (SRC MAC Address) (the identification address of an identification section through which a communication signal passes in the multiplex system) at which a signal is output from the access gateway 61, and a destination identification address (DSC MAC Address) (the identification address of a signal identification section through which a communication signal passes in the multiplex system) at which a signal is input to the subscriber multiplexing/demultiplexing apparatuses 4n. As a source identification address and destination identification address, the addresses of apparatuses from/to which signals are output/input or the addresses of the ports of apparatuses from/to which signals are output/input are used.

[0062]

An example of how a MAC address is added in the Ethernet/IEEE 802.3 interface block 6nD will be

describe below with reference to Fig. 4.

As shown in Fig. 4, as the MAC address (DST MAC Address/SRC MAC Address) to be added to the Ethernet/IEEE 802.3 frame output from the access gateway 61 to the subscriber multiplexing/demultiplexing apparatuses 4n, 2011/3011 is added. 2011 is the address of an output port directed from the subscriber multiplexing/demultiplexing apparatuses 4n to the subscriber apparatus 2nm, and 3011 is the address of the output port of the access gateway 61 directed from the access gateway 61 to the subscriber multiplexing/demultiplexing apparatuses 4n as a destination.

[0063]

The operation of this embodiment will be described next with reference to Figs. 1 to 14.

Transmission of an IP packet from the subscriber (personal computer 1nm1) side to the backbone network 81 side will be described first.

When the personal computer 1nm1 tries to access the Internet, the computer transmits an IP packet to the subscriber apparatus 2nm.

Upon reception of this IP packet, the subscriber apparatus 2nm adds a PPP header to the received IP packet (IP and PPP of ATUU-R in Fig. 5), and then adds the frame header of an Ethernet/IEEE 802.3 frame (Fig. 12) (MAC of ATUU-R in Fig. 5). The subscriber apparatus 2nm performs analog modulation with respect to the Ethernet/IEEE 802.3 frame packet to which the frame header of the Ethernet/IEEE 802.3 frame is added to convert it into a 100-kb/s ADSL/VDSL signal, and transmits it to the subscriber

multiplexing/demultiplexing apparatuses 4n.

[0064]

The ADSL/VDSL signal transmitted from the subscriber apparatus 2nm through the ADSL/VDSL interface 3nmU is received by the corresponding ADSL/VDSL interface block 4n1 of the subscriber multiplexing/demultiplexing apparatuses 4n. The ADSL/VDSL interface block 4n1 extracts an Ethernet/IEEE 802.3 frame packet and an MAC address in the packet from the ADSL/VDSL signal. The extracted Ethernet/IEEE 802.3 frame packet is written in a corresponding FIFO of the FIFOs equal in number to subscriber lines (the number of ADSL/VDSL interfaces 3nmU)(M) constituting the multiplexing block 4n2 on the basis of the extracted MAC (the MAC of the DSLAM in Fig. 5).

[0065]

The Ethernet/IEEE 802.3 frame packet transmitted over an ADSL/VDSL signal on each ADSL/VDSL interface 3nmU is written in a FIFO of the M FIFOs of the multiplexing block 4n2 which corresponds to the input Ethernet/IEEE 802.3 frame packet upon referring to the byte count of the IP packet indicated by the byte count field (length field) (the field located between the third and fourth bytes of the IP packet) in the PPP packet contained in the packet.

Packets are multiplexed by writing Ethernet/IEEE 802.3 frame packets in the M FIFOs and reading out Ethernet/IEEE 802.3 frame packets from the first FIFO to the Nth FIFO of the M FIFOs in the order named.

[0066]

An example of multiplexing will be described

below.

For example, as shown in Fig. 4, the Ethernet/IEEE 802.3 frame packet (2nm in Figs. 6 and 7) in the ADSL/VDSL signal transmitted from the subscriber apparatus 2nm through the ADSL/VDSL interface 3nmU having a throughput of about several 100 kb/s has 1021 as the source identification address of a MAC address, and 2011 as a destination identification address (1021 is the address of the subscriber apparatus 2nm, and 2011 is the address of the corresponding input port of the subscriber multiplexing/demultiplexing apparatuses 4n). This Ethernet/IEEE 802.3 frame packet is designated by a source identification address and input to a FIFO 4n2m (Fig. 7) storing a packet queue to be written therein.

[0067]

Write operation similar to this write operation is also performed for the respective Ethernet/IEEE 802.3 frame packets input from other subscriber apparatuses 2n1, 2n2,..., 2n(m-1), 2n(m+1), 2n(m+2),..., 2nM. The FIFOs used for the respective Ethernet/IEEE 802.3 frame packets are a FIFO 4n21, FIFO 4n22,..., FIFO 4n2(m-1), FIFO 4n2(m+1), FIFO 4n2(m+2), and FIFO 4n2M.

After this write operation, read operation is performed with respect to the FIFO 4n21, FIFO 4n22,..., FIFO 4n2M in the order named.

[0068]

With the above write and read operations, Ethernet/IEEE 802.3 frame packets are multiplexed. In this case, the Ethernet/IEEE 802.3 frame packet to which the address of the corresponding input port of the subscriber multiplexing/demultiplexing apparatuses 4n or

the address of the subscriber apparatus 2nm is added as a MAC address for identifying the subscriber is read out from the subscriber multiplexing/demultiplexing apparatuses 4n at a throughput of 10 Mb/s and multiplexed. The multiplexed Ethernet/IEEE 802.3 signal is then transmitted from the Ethernet/IEEE 802.3 interface block 4n3 to the access gateway 61 through the Ethernet/IEEE 802.3 interface block 5nU.

[0069]

At the access gateway 61, the Ethernet/IEEE 802.3 frame packet and its MAC address which are transmitted over an Ethernet/IEEE 802.3 signal in the Ethernet/IEEE 802.3 frame form are extracted. In addition, the Ethernet/IEEE 802.3 interface block 6nU discriminates a PPP packet in the packet is a PPP control packet or a PPP data packet.

This discrimination is performed on the basis of the value of a protocol field (Fig. 21) of the input PPP packet.

[0070]

If the input PPP packet is a PPP control packet, i.e., the value of the protocol field of the input PPP packet is c021 or 8021, the Ethernet/IEEE 802.3 frame packet is stored as one of queues 6111 to 611M (Fig. 10) in a memory (not shown) in the packet switch module 611 for each subscriber apparatus on the basis of the MAC address. Thereafter, the PPP control packet of the Ethernet/IEEE 802.3 frame is transferred to the CPU board 614A. That is, the packet is switched by the packet switch module 611 (MAC of AG in Fig. 15), and a CPU board 614 transfers a PPP control packet for PPP processing required between the CPU board 614 and

the subscriber apparatus 2nm, as shown in Fig. 2, thereby performing the processing shown in Figs. 22 and 23. This processing itself is known link establishment processing.

[0071]

This operation will be briefly described below.

When a PPP control packet is transferred between the CPU board 614 and the subscriber apparatus 2nm, the control information of the PPP control packet is exchanged between them. With this operation, a series of operations, e.g., authentication, accounting, band allocation, and minimum delay processing (assurance of Qos), is complete at the access gateway 61.

At the access gateway 61, in performing PPP processing for each subscriber, as a PPP control packet to the transferred, an LCP packet is transferred first, and then an NCP packet is transferred (Fig. 23). With this operation, PPP processing is performed.

[0072]

When a link is established between the personal computer 1nm1 and the access gateway 61 in this manner, IP data is output from the personal computer 1nm1. The output IP data is formed into an Ethernet/IEEE 802.3 frame packet and transmitted to the access gateway 61 through the subscriber apparatus 2nm and subscriber multiplexing/demultiplexing apparatuses 4n in the above manner.

Whether the PPP packet in this Ethernet/IEEE 802.3 frame packet is a PPP data packet or not is determined depending on whether the value of the protocol field of the input PPP packet indicates 0021 or not (Fig. 21). In this case as well, the PPP data

packet is stored as one of the queues 6111 to 611M (Fig. 10) in the memory (not shown) in the packet switch module 611 on the basis of the MAC address. Thereafter, the PPP header added by the subscriber apparatus 2nm for PPP processing required between the subscriber apparatus 2nm, which has transmitted the PPP data packet, and the access gateway 61 is removed from each PPP data packet by the POS OC-12C interface block 612. A new PPP header for POS is added to the PPP packet from which the PPP head has been removed.

The frame (Fig. 17B) to which the new PPP header is added is transmitted over a 620-Mb/s POS signal (Fig. 18) (POS OC-12c signal) in the SDH/SONET frame form from the POS OC-12C interface block 612 to the backbone network 81 through the POS OC-12C interface 71.

[0073]

Transmission of an IP packet from the backbone network 81 side to the subscriber (personal computer 1nm1) side will be described next.

In transferring an IP packet downward from the backbone network 81, a 620-Mb/s POS signal (Fig. 18) in the SDH/SONET frame form, which carries a packet (Fig. 17B) of a PPP packet in PPP packet frame containing the PPP packet obtained by performing PPP header addition processing (PPP Encapsulation) (mapping) with respect to the IP packet in the backbone network 81, is transmitted to the access gateway 61 through the POS OC-12C interface 71.

[0074]

In the POS OC-12C interface block 613 which receives the packet of the PPP packet in PPP packet

frame carried on the POS signal, PPP processing between the backbone network and the AG is performed. In the PPP processing between the backbone network and the AG, for example, a maximum packet length: MTU (Maximum Transfer Unit) size of packets to be exchanged between the backbone network and the AG is determined. In the PPP processing, the PPP header of the PPP packet in the packet of the PPP packet in PPP packet frame is removed.

After the PPP processing between the backbone network and the AG, 0021 is added as the value of a protocol field for PPP processing for transfer to a subscriber to the PPP packet, and the PPP packet and the IP address of the PPP packet are output from the POS OC-12C interface block 613 to the packet switch module 611.

[0075]

Any PPP packet transferred to the packet switch module 611 is written in the form of a queue in the memory on a subscriber basis on the basis of the IP address (Fig. 11). The written queues 6111 to 611M are respectively assigned priorities. For example, referring to Fig. 11, the highest priority is assigned to the queue 611m to be sent to the subscriber apparatus 2nm, and lower priorities are assigned to the remaining queues 6111, 6112,..., 611n(m-1), 611(m+1), 611(m+2),..., 611M.

The queue 611m to which the highest priority is assigned, therefore, is performed preferentially as compared with the PPP packets in the remaining queues. For this reason, a delay of the PPP packet written in the queue 611m is output to the Ethernet/IEEE 802.3 interface block 6nD after a lapse of a minimum delay

time.

In transmission of such a PPP packet, if a band to be secured is 6 Mb/s, traffic shaping (packet fragmentation) is performed to set the maximum band to 6 Mb/s.

[0076]

In the packet switch module 611, packet switching of the PPP packet is performed, and the packet is transferred from the packet switch module 611 to the Ethernet/IEEE 802.3 interface block 6nD.

The Ethernet/IEEE 802.3 interface block 6nD adds the MAC address of each subscriber (MAC of AG in Fig. 5) to the packet to convert it into an Ethernet/IEEE 802.3 signal in the Ethernet/IEEE 802.3 frame form. This signal is transmitted to the subscriber multiplexing/demultiplexing apparatuses 4n.

[0077]

The Ethernet/IEEE 802.3 signal is received by the Ethernet/IEEE 802.3 interface block 4n4 of the subscriber multiplexing/demultiplexing apparatuses 4n. The Ethernet/IEEE 802.3 interface block 4n4 outputs an Ethernet/IEEE 802.3 frame packet and its MAC address from the Ethernet/IEEE 802.3 signal.

[0078]

The Ethernet/IEEE 802.3 frame packet and MAC address output from the Ethernet/IEEE 802.3 interface block 4n4 are supplied to the demultiplexing block 4n5. In a plurality of FIFOs of the demultiplexing block 4n5, the Ethernet/IEEE 802.3 frame packet is demultiplexed on the basis of the MAC address (MAC of DSLAM in Fig. 5). For this demultiplexing, for example, the Ethernet/IEEE 802.3 frame packet to be transmitted to the subscriber

apparatus 2nm is written in a corresponding FIFO 4n5m.

Each of these FIFOs 4n51 to 4n5M has a storage capacity large enough to satisfy QoS in association with the throughput of the ADSL/VDSL interface 3nmU and the write and read speeds of each FIFO. Even if the packet length increases to exceed the storage capacity of each FIFO, since the packet is transmitted upon fragmentation by traffic shaping in the access gateway 61, no FIFO overflows.

[0079]

Each of the packets stored in the queue form in the FIFOs is read out from each FIFO, and the signal is converted into a VDSL/ADSL signal carrying the Ethernet/IEEE 802.3 frame packet in the ADSL/VDSL interface 4n6. This VDSL/ADSL signal is then transmitted to the subscriber apparatus 2nm. The subscriber apparatus 2nm reconstructs the IP packet (MAC of ATUU-R in Fig. 5) by removing the frame header of the Ethernet/IEEE 802.3 frame and the PPP header as header information in the received VDSL/ADSL signal. This IP packet is transmitted from the subscriber apparatus 2nm to the personal computer 1nm1.

[0080]

As described above, according to the arrangement of this example, the subscriber multiplexing/demultiplexing apparatuses 4n can multiplex Ethernet/IEEE 802.3 frame packets from the respective subscriber apparatuses 2nm on the basis of the MAC addresses, output the resultant signal as an Ethernet/IEEE 802.3 signal, and output each Ethernet/IEEE 802.3 frame packet in the Ethernet/IEEE 802.3 signal. The subscriber

multiplexing/demultiplexing apparatuses 4n can also demultiplex an Ethernet/IEEE 802.3 frame packet from the access gateway 61 on the basis of the MAC address.

In addition, processing in each subscriber apparatus 2nm, each subscriber multiplexing/demultiplexing apparatuses 4n, and access gateway 61 can be performed by using MAC addresses, and the AAL5 layer required in the prior art is not required. This makes it possible to eliminate the necessity of an ATM switch in the prior art and simplify the system arrangement.

Under this system simplification, QoS of each subscriber can be ensured.

[0081]

◇ Second Embodiment

Fig. 15 shows the electrooptical arrangement of an access network system according to the second embodiment of the present invention. Fig. 16 shows the detailed arrangement of the access network system. Fig. 17 shows the format of a PPP packet and the format of a PPP packet in PPP packet. Fig. 18 shows the format of an SDH/SONET frame.

The arrangement of this embodiment greatly differs from that of the first embodiment in that the subscriber multiplexing/demultiplexing apparatus and access gateway in the first embodiment are connected to each other through a POS OC-3c interface, and the subscriber multiplexing/demultiplexing apparatus and access gateway are changed in accordance with this change in arrangement.

[0082]

More specifically, an access network system

10A is a system for performing PPP processing equivalent to the PPP processing performed by using the MAC layer in the first embodiment and is roughly comprised of a subscriber apparatus 2nm, subscriber multiplexing/demultiplexing apparatus 4nA, and access gateway 61A.

The subscriber multiplexing/demultiplexing apparatus 4nA is connected to the access gateway 61A through a POS OC-3c interface 5nAU and POS OC-3c interface 5nAD.

[0083]

The subscriber multiplexing/demultiplexing apparatus 4An is comprised of an ADSL/VDSL interface block 4n1, multiplexing block 4n2, POS OC-3c interface block 4n3A, POS OC-3c interface block 4n4A, demultiplexing block 4n5A, and ADSL/VDSL interface block 4n6A. "OC-3c" of the POS OC-3c interface block 4n3A and POS OC-3c interface block 4n4A is a notation representing a communication speed, which is 155 Mb/s.

[0084]

The access gateway 61A includes a POS OC-3c interface block 6nUA, packet switch module 611A, POS OC-12c interface block 612, POS OC-12c interface block 613, CPU board 614A, and POS OC-3c interface block 6nDA.

[0085]

The constituent elements of the subscriber multiplexing/demultiplexing apparatus 4An will be described in detail first.

The POS OC-3c interface block 4n3A executes an interface function between the subscriber multiplexing/demultiplexing apparatus 4An and the access gateway 61A. More specifically, the POS OC-3c interface

block 4n3A converts a PPP packet in a multiplexed POS OC-3c frame packet into a POS signal (POS OC-3c signal) in the SDH/SONET frame form containing a packet of a PPP packet in PPP packet frame, and outputs it onto the POS OC-3c interface 5nAU.

[0086]

The POS OC-3c interface block 4n4A executes an interface function between the access gateway 61A and the subscriber multiplexing/demultiplexing apparatus 4An. More specifically, the POS OC-3c interface block 4n4A receives the POS signal output from the POS OC-3c interface block 6nDA of the access gateway 61A, extracts a PPP packet and IP address in each PPP packet in PPP packet, and transfers the PPP packet in the PPP packet in PPP packet and the IP address in the PPP packet to the demultiplexing block 4n5A.

The demultiplexing block 4n5A demultiplexes the PPP packet transferred from the POS OC-3c interface block 4n4A by using a plurality of FIFOs. This demultiplexing is performed on the basis of the input IP address.

The ADSL/VDSL interface block 4n6A is provided for each subscriber apparatus 2nm, and executes an interface function for each PPP packet demultiplexed by the demultiplexing block 4n5A. More specifically, the ADSL/VDSL interface block 4n6A converts each demultiplexed PPP packet into an ADSL/VDSL signal in the Ethernet/IEEE 802.3 frame form, and transfers the ADSL/VDSL signal to a corresponding subscriber apparatus.

[0087]

The respective constituent elements of the access gateway 61A will be described next.

The POS OC-3c interface block 6nUA executes an interface function for the POS signal input from the subscriber multiplexing/demultiplexing apparatus 4An through the POS OC-3c interface 5nAU. More specifically, the POS OC-3c interface block 6nUA receives a POS signal, extracts a PPP packet in a PPP packet in PPP packet and an IP address in the PPP packet, and transfers the extracted PPP packet and the IP address in the PPP packet to the packet switch module 611A.

[0088]

The POS OC-3c interface block 6nUA refers to the value indicated by the protocol field of the extracted PPP packet and performs the first discrimination, i.e., discriminating the extracted PPP packet as a PPP data packet if the value is "0021", and the second discrimination, i.e., discriminating the extracted PPP packet as a PPP control packet if the value is "8021" or "c021". The POS OC-3c interface block 6nUA then supplies the discrimination result to the packet switch module 611A.

[0089]

The packet switch module 611A performs switching with respect to PPP packets on the basis of the IP addresses and discrimination results transferred from the POS OC-3c interface block 6nUA, and also performs switching with respect to PPP packets on the basis of the IP addresses transferred from the POS OC-12c interface block 613.

[0090]

The CPU board 614A performs transfer processing of a PPP control packet for the first PPP processing required between the CPU board 614A of the

access gateway 61A and the subscriber apparatus 2nm, and transfer processing of a PPP control packet for the second PPP processing required between the CPU board 614A of the access gateway 61A and the subscriber multiplexing/demultiplexing apparatus 4nA under program control (Figs. 22 and 23).

The contents of the first PPP processing described are the same as those of the PPP processing executed between the CPU board 614 of the access gateway 61 and the subscriber apparatus 2nm in the first embodiment.

The contents of the second PPP processing are the same as those of the PPP processing executed between the backbone network 81 and the access gateway 61 in the first embodiment. In this processing, for example, a maximum packet length: MTU (Maximum Transfer Unit) size of packets to be exchanged between the access gateway and the subscriber multiplexing/demultiplexing apparatus is determined.

[0091]

The POS OC-3c interface block 6nDA receives the PPP packet switched by the packet switch module 611A, reassembles it into a PPP packet in PPP packet, converts it into a POS signal in the SDH/SONET form, and outputs it onto the POS OC-3c interface 5nAD.

[0092]

The CPU board 614A of the access gateway 61A and the subscriber apparatus 2nm are configured as a whole to perform the first PPP processing.

The CPU board 614A of the access gateway 61A and the subscriber multiplexing/demultiplexing apparatus 4nA are configured as a whole to perform the second PPP

processing.

The arrangements of the respective sections in the second embodiment are the same as those in first embodiment except for these arrangements. For this reason, the same reference numerals as in the first embodiment denote the same parts in the second embodiment, and a description thereof will be omitted.

[0093]

The operation of this embodiment will be described next with reference to Figs. 15 to 18.

The operation of this embodiment is the same as that of the first embodiment except for the following point.

The PPP packet in each Ethernet/IEEE 802.3 frame packet multiplexed by the multiplexing block 4n2 of the subscriber multiplexing/demultiplexing apparatus 4nA is formed into a PPP packet in PPP packet (Fig. 17B) in the POS OC-3c interface block 4n3A. This packet is then converted into a POS signal (POS OC-3c signal) in the SDH/SONET frame form and transmitted onto the POS OC-3c interface 5nAU.

[0094]

Upon reception of the POS signal through the POS OC-3c interface 5nAU, the POS OC-3c interface block 6nUA extracts a PPP packet and IP address from the PPP packet in PPP packet.

The POS OC-3c interface block 6nUA also checks the contents of a protocol field in the extracted PPP packet to discriminate whether the PPP packet is a PPP data packet or PPP control packet. The POS OC-3c interface block 6nUA then transfers the PPP packet, IP address, and discrimination result to the packet switch

module 611A.

The discrimination result includes the first discrimination result indicating that the PPP packet is a PPP data packet, and the second discrimination result indicating that the PPP packet is a PPP control packet.

[0095]

Upon reception of the PPP packet, IP address, and first discrimination result, the packet switch module 611A switches the PPP packet to the POS OC-12c interface block 613 in accordance with the IP address as in the first embodiment. The POS OC-12c interface block 613 then transmits the POS signal in the SDH/SONET frame form (Fig. 18) onto the POS OC-12C interface 71.

[0096]

Upon reception of the PPP packet, IP address, and second discrimination result, the packet switch module 611A switches the PPP packet to the CPU board 614A in accordance with the IP address as in the first embodiment.

[0097]

The CPU board 614A performs transfer processing of a PPP control packet between the CPU board 614A of the access gateway 61A and the subscriber apparatus 2nm shown in Figs. 22 and 23, and transfer processing of a PPP control packet between the CPU board 614A of the access gateway 61A and the subscriber multiplexing/demultiplexing apparatus 4nA on the basis of the second discrimination under program control. The CPU board 614A then performs the first PPP processing required between the CPU board 614A of the access gateway 61A and the subscriber apparatus 2nm, and the second PPP processing required between the CPU board

614A of the access gateway 61A and the subscriber multiplexing/demultiplexing apparatus 4nA.

[0098]

As in the first embodiment, the POS OC-12c interface block 613 extracts a PPP packet in a PPP packet in PPP packet and an IP address in the PPP packet from the POS signal in the SDH/SONET form transmitted from the backbone network 81 through the POS OC-12C interface 71, and transfers them to the packet switch module 611A. The packet switch module 611A then performs switching based on the IP address and transfers the PPP packet to the POS OC-3c interface block 6nDA.

[0099]

The POS OC-3c interface block 6nDA converts the received PPP packet into a POS signal (POS OC-3c signal) in the SDH/SONET form, and transmits it onto a POS OC-3c interface 5nA.

[0100]

Upon reception of the POS signal from the POS OC-3c interface 5nA, the POS OC-3c interface block 4n4A extracts a PPP packet and an IP address in the PPP packet from each PPP packet in PPP packet in the POS signal, and transfers them to the demultiplexing block 4n5A.

The demultiplexing block 4n5A demultiplexes each received PPP packet on the basis of the received IP address and transfers the packet to the ADSL/VDSL interface block 4n6A.

[0101]

The ADSL/VDSL interface block 4n6A converts the PPP packet transferred from the demultiplexing block 4n5A into an ADSL/VDSL signal in the Ethernet/IEEE 802.3

frame form, and transmits the ADSL/VDSL signal to a corresponding subscriber apparatus 4nm.

[0102]

As described above, according to the arrangement of this embodiment, the subscriber multiplexing/demultiplexing apparatuses 4n can multiplex Ethernet/IEEE 802.3 frame packets from the respective subscriber apparatuses 2nm on the basis of MAC addresses and transmit the resultant packet as a POS signal to the access gateway 61A.

Each PPP packet in the POS signal transmitted from the access gateway 61A can be demultiplexed on the basis of the IP addresses.

In addition, this embodiment is configured such that processing in each subscriber apparatus 2nm and multiplexing in the subscriber multiplexing/demultiplexing apparatus 4nA can be performed by using MAC addresses, and demultiplexing in the access gateway 61A and each subscriber multiplexing/demultiplexing apparatus 4nA can be performed by using IP addresses. This arrangement eliminates the necessity of the AAL5 layer which is required in the prior art. This makes it possible to eliminate the necessity of an ATM switch in the prior art and simplify the system arrangement.

Under this system simplification, QoS of each subscriber can be ensured.

[0103]

The present invention has been described in detail above with reference to the accompanying drawings. However, the present invention is not limited to these embodiments, and the present invention incorporates a

change in design and the like within the scope of the present invention.

For example, the subscriber multiplexing/demultiplexing apparatuses 4n may multiplex the PPP packets in Ethernet/IEEE 802.3 frame packets instead of the packets. With this change, the Ethernet/IEEE 802.3 interface blocks 4n1 and 4n3 need to be changed.

In addition, the subscriber multiplexing/demultiplexing apparatuses 4n and 4nA may perform multiplexing on the basis of the IP addresses of PPP packets.

Furthermore, the present invention can be executed to convert the above packets into other communication signals and multiplex/demultiplex the communication signals.

Multiplexing and demultiplexing in the subscriber multiplexing/demultiplexing apparatuses 4n and 4nA can be executed by systems other than the access network system.

Moreover, the present invention can be executed even if a signal in a frame form other than the SDH/SONET frame form is used as a POS signal.

[0104]

[Effect of the Invention]

As has been described above, according to the arrangement of the present invention, a plurality of communication signals can be multiplexed in accordance with identification addresses, and a multiplexed signal obtained by multiplexing a plurality of communication signals can be demultiplexed by using identification addresses.

In addition, PPP packets and the like in a multiplexed signal obtained by multiplexing a plurality of PPP packets used for transmission/reception through the Internet can be demultiplexed by using the IP addresses of the PPP packets.

Furthermore, any process in a plurality of subscriber apparatuses, a plurality of subscriber multiplexing/demultiplexing apparatuses, and access gateway in an access network system can be performed by using MAC addresses or IP addresses. This eliminates the necessity of the AAL5 layer required in the prior art, and hence no ATM switch in the prior art is required. This makes it possible to simplify the system arrangement.

This effect can also be obtained when processing in a plurality of subscriber apparatuses and multiplexing in a plurality of subscriber multiplexing/demultiplexing apparatuses in an access network system can be performed by using MAC addresses, and demultiplexing in an access gateway and a plurality of subscriber multiplexing/demultiplexing apparatuses can be performed by using IP addresses.

Under this system simplification, QoS of each subscriber can be ensured.

[Brief Explanation of the Drawings]

[Fig. 1]

Fig. 1 is a block diagram showing the electrical arrangement of an access network system according to the first embodiment of the present invention;

[Fig. 2]

Fig. 2 is a block diagram showing the flow of

a PPP control packet in the detailed arrangement of the access network system;

[Fig. 3]

Fig. 3 is a block diagram showing the flow of a PPP data packet in the detailed arrangement of the access network system;

[Fig. 4]

Fig. 4 is a block diagram showing an example of how MAC addresses are assigned to the subscriber apparatus, subscriber multiplexing/demultiplexing apparatus, and access gateway shown in Figs. 2 and 3;

[Fig. 5]

Fig. 5 is a view showing a protocol stack;

[Fig. 6]

Fig. 6 is a block diagram schematically showing the functions of the ADSL/VDSL interface block, multiplexing clock, and Ethernet/IEEE 802.3 interface block shown in Fig. 2;

[Fig. 7]

Fig. 7 is a view showing the process of upward multiplexing in the subscriber multiplexing/demultiplexing apparatus;

[Fig. 8]

Fig. 8 is a block diagram schematically showing the functions of the Ethernet/IEEE 802.3 interface block, demultiplexing block, and ADSL/VDSL interface block shown in Fig. 2;

[Fig. 9]

Fig. 9 is a view showing the process of downward multiplexing in the subscriber multiplexing/demultiplexing apparatus;

[Fig. 10]

Fig. 10 is a schematic view showing how queue write and queue read in the upward direction are performed in the packet switch module shown in Figs. 2 and 3;

[Fig. 11]

Fig. 11 is a schematic view showing how queue write and queue read in the downward direction are performed in the packet switch module shown in Figs. 2 and 3;

[Fig. 12]

Fig. 12 is a view showing the format of a PPP packet and the format of an Ethernet/IEEE 802.3 frame;

[Fig. 13]

Fig. 13 is a view showing the difference between the format of an Ethernet frame and the format of an IEEE 802.3 frame;

[Fig. 14]

Fig. 14 is a view showing the format of an IP packet;

[Fig. 15]

Fig. 15 is a block diagram showing the electrooptical arrangement of an access network system according to the second embodiment of the present invention;

[Fig. 16]

Fig. 16 is a block diagram showing the detailed arrangement of the access network system;

[Fig. 17]

Fig. 17 is a view showing the format of a PPP packet and the format of a PPP packet in PPP packet;

[Fig. 18]

Fig. 18 is a view showing the format of an

SDH/SONET frame;

[Fig. 19]

Fig. 19 is a block diagram showing the electrical arrangement of a conventional access network system;

[Fig. 20]

Fig. 20 is a view showing a conventional protocol stack;

[Fig. 21]

Fig. 21 is a view showing the contents of packet data in correspondence with the values of protocol fields in PPP packets;

[Fig. 22]

Fig. 22 is a view showing PPP link processing; and

[Fig. 23]

Fig. 23 is a view showing a PPP processing sequence.

[Explanation of the Reference Numerals and Signs]

10, 10A	Access network system 2nm Subscriber apparatus (Communication signal transmitting section, Communication signal receiving section)
4n, 4nA	Subscriber multiplexing/demultiplexing apparatus
4n1	Ethernet/ IEEE 802.3 interface block (Address extracting means, First address extracting means, First receiving means)
4n2	Multiplexing block (Multiplexing means)
4n4	Ethernet/ IEEE 802.3 interface block (Address extracting means, Second address extracting means, Second receiving means)

4n5, 4n5A	Multiplexing block (Multiplexing means)
4n4A	POS OC-3C interface block (Address extracting means, Second address extracting means)
4n3	Ethernet/IEEE 802.3 interface block (First transmitting means)
4n6	Ethernet/IEEE 802.3 interface block (Second transmitting means)
4n6A	Ethernet/IEEE 802.3 interface block
4n3A	POS OC-3C interface block
5nUA	POS OC-3C interface (Interface)
5nU, 5nD	Ethernet/ IEEE 802.3 interface
5nDA	POS OC-3C interface
61, 61A	Access gateway (Communication signal receiving section, Communication signal transmitting section, Protocol termination apparatus)
612	POS OC-12C interface block (First interface block)
6nU	Ethernet/IEEE 802.3 interface block (Second interface block)
6nD	Ethernet/IEEE 802.3 interface block (Third interface block)
6nUA	POS OC-3C interface block (Second interface block)
6nDA	POS OC-3C interface block (Third interface block)
4n3A	POS OC-3C interface block
5nUA	POS OC-3C interface block (Interface)
611, 611A	packet switch module (Switching means)
614, 614A	CPU board (PPP processing means)
613	POS OC-12c interface block

[Document Name] Abstract

[Abstract]

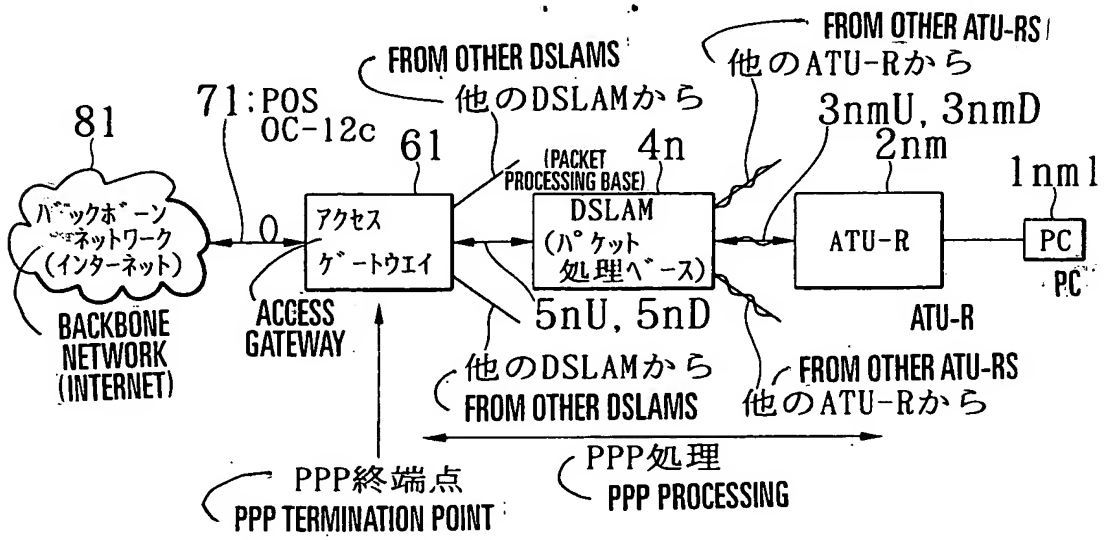
[Problem] To simplify an access network system

[Solving Means] Multiplexing or multiple-separating of a subscriber multiplexing/ multiple-separating device 4n, to which a plurality of subscriber devices 2nm are connected is performed based on the MAC access in the packet which is housed in a received the Ethernet (R)/IEEE802.3 frame signal. Switching of the packet of the Ethernet (R)/IEEE802.3 frame received at an access gateway 61, is performed, based on the MAC access in the packet. A control packet is transferred between the access gateway 61 and a subscriber device 4nm, for PPP process.

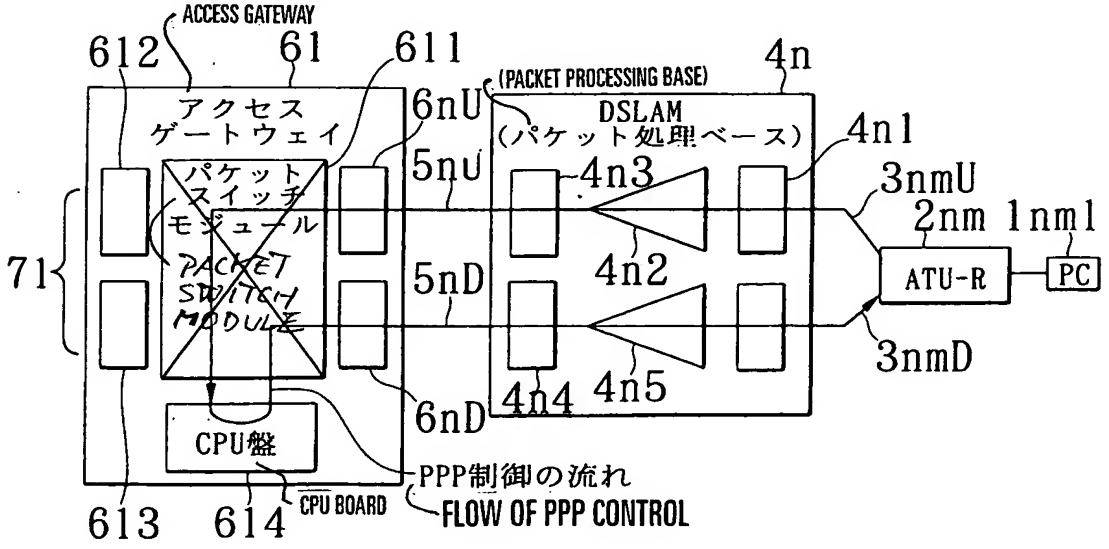
[Selected Figure] Fig. 1

【書類名】　図面
DOCUMENT NAME　DRAWINGS

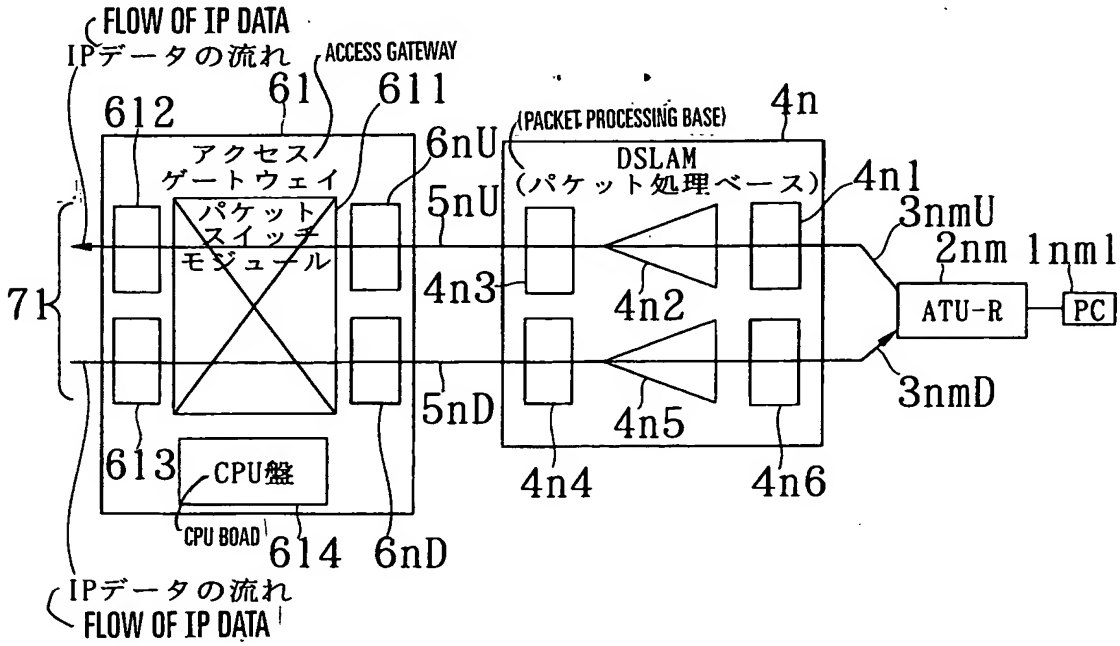
【図１】
FIG. 1



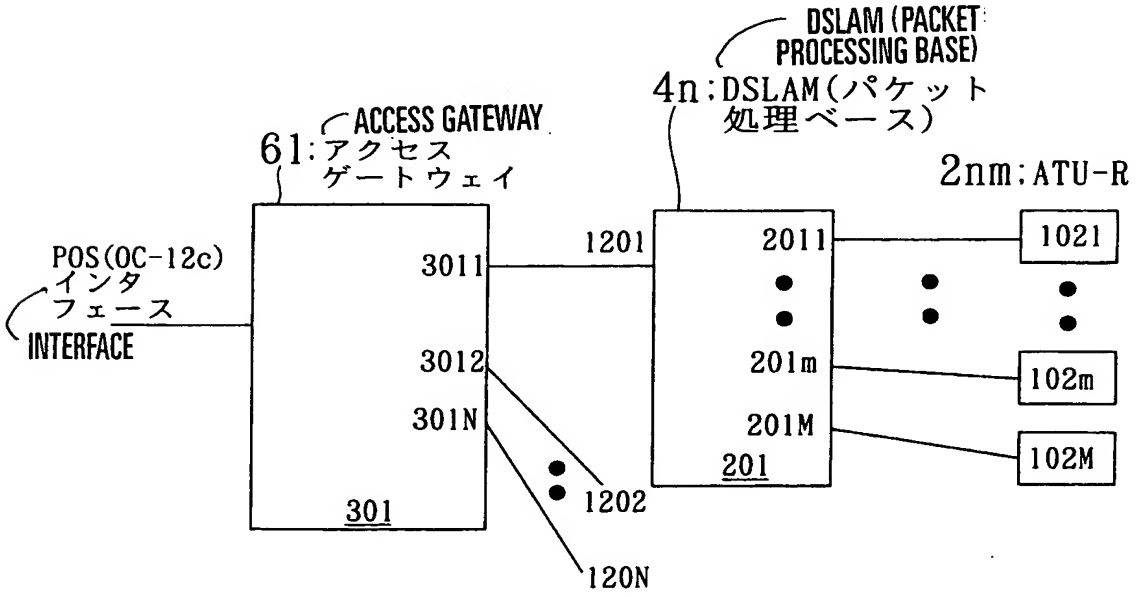
【図２】
FIG. 2



【図３】
FIG. 3



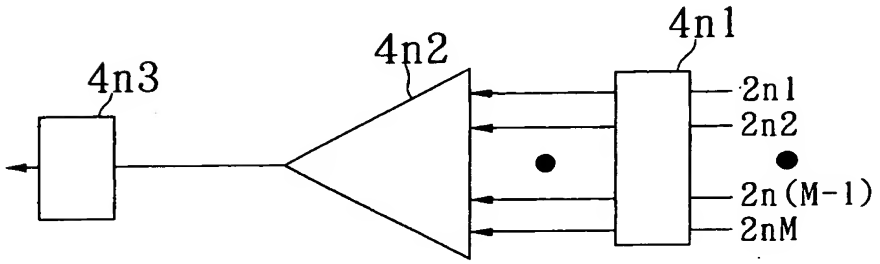
【図４】
FIG. 4



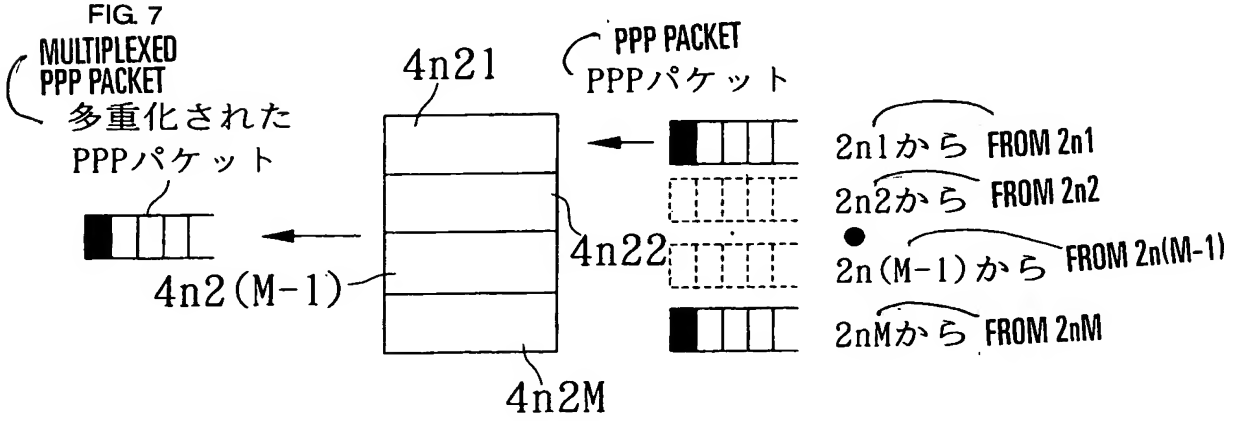
【図５】
FIG. 5

61: AG	4n: DSLAM	2nm: ATU-R
IP		IP
PPP		PPP
MAC	MAC	MAC
PHY	PHY	PHY

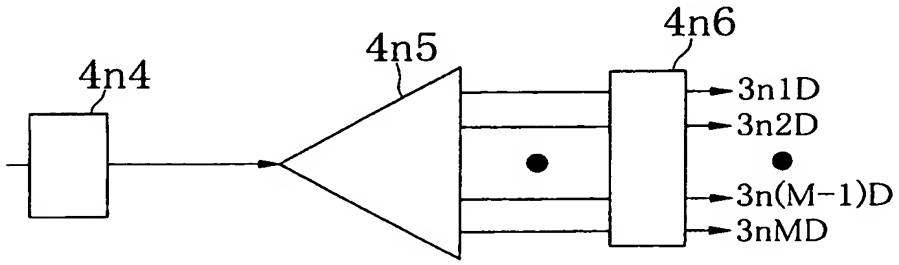
【図６】
FIG. 6



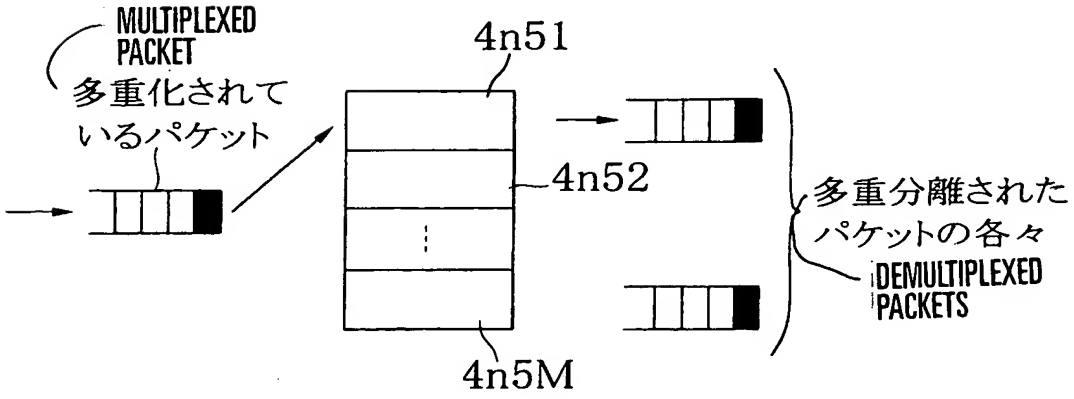
【図７】
FIG. 7



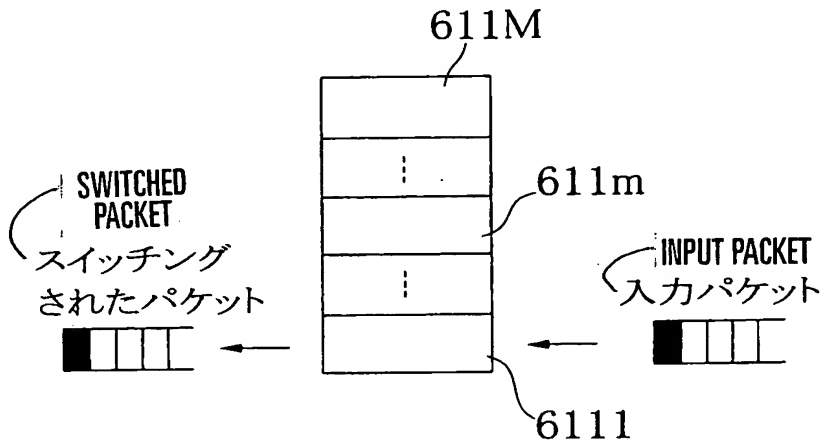
【図８】
FIG. 8



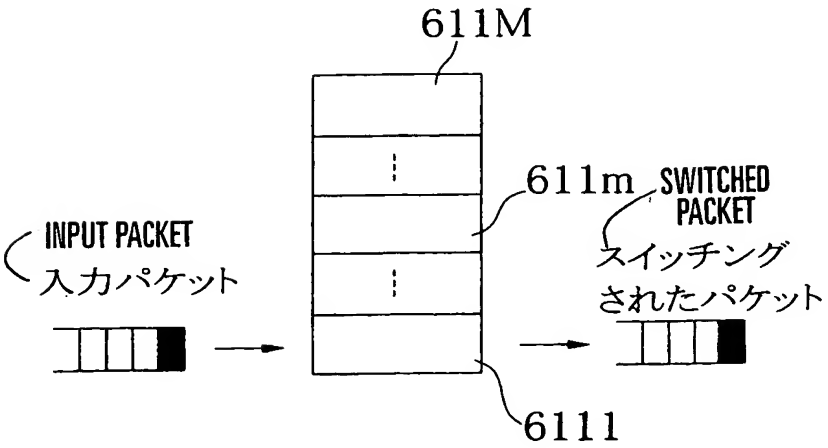
【図９】
FIG. 9



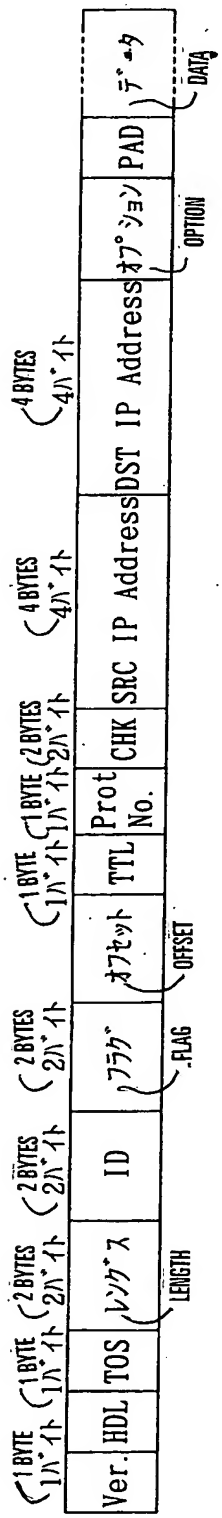
【図１０】
FIG. 10



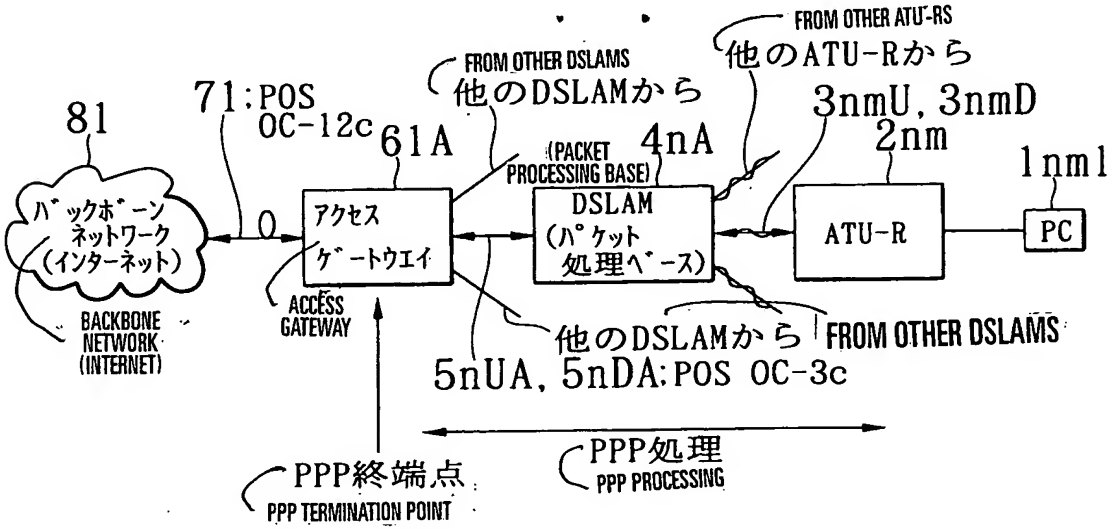
【図１１】
FIG. 11



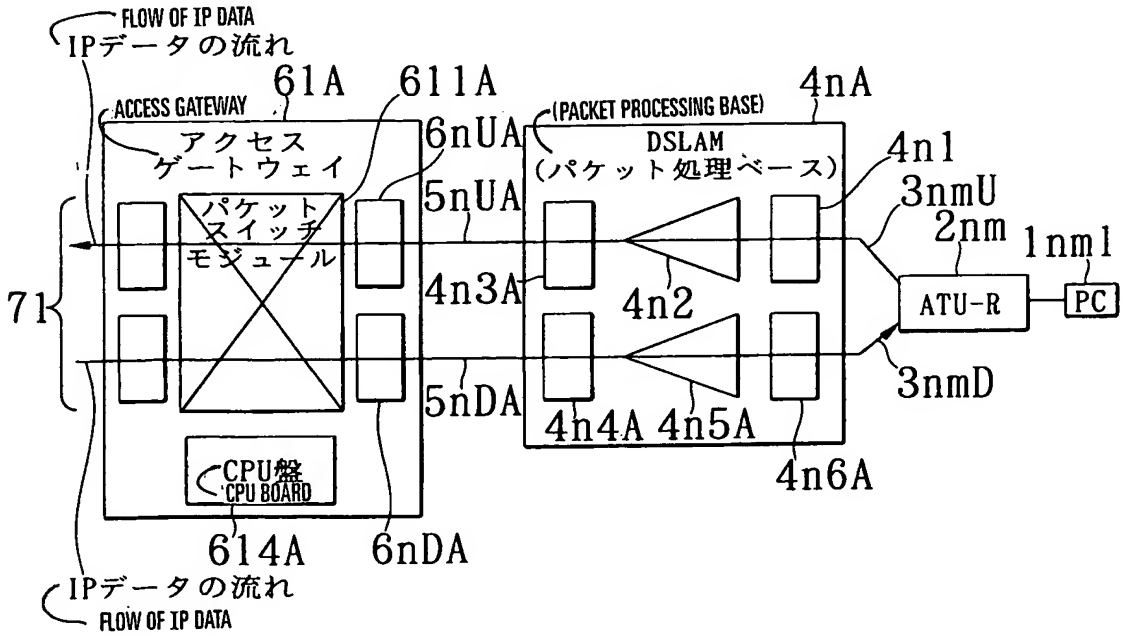
【図１４】
FIG. 14


Ver.
HDL
TOS
レングス
ID
フラグ
オフセット
TTL
Prot No.
CHK
SRC IP Address
DST IP Address
オプション
PAD
データ
1 BYTE 1バイト
2 BYTES 2バイト
4 BYTES 4バイト
LENGTH
FLAG
OFFSET
OPTION
DATA

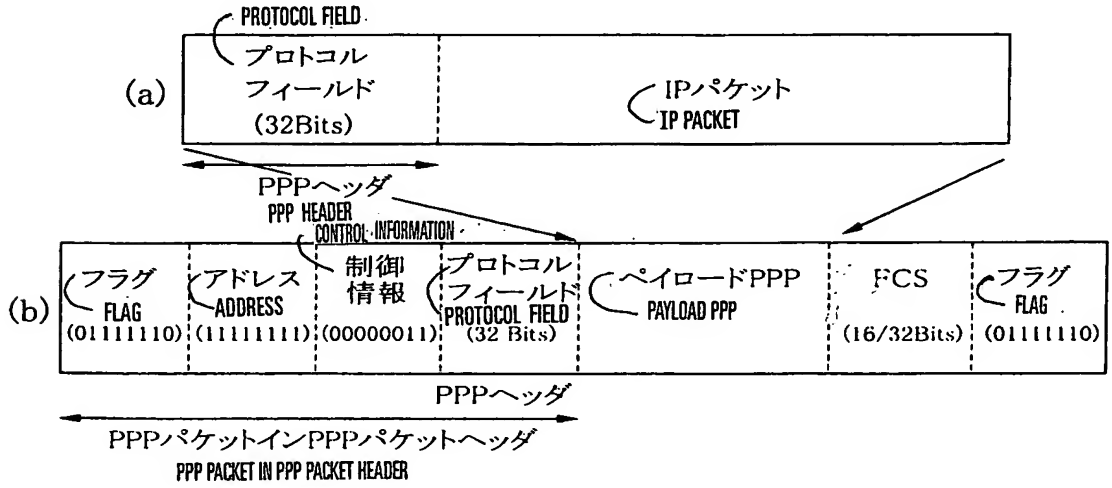
【図１５】
FIG. 15



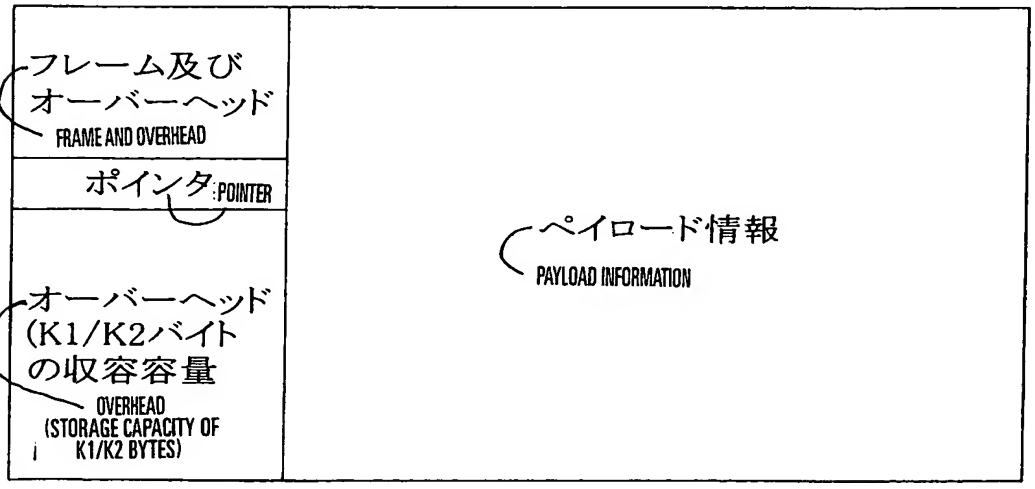
【図１６】
FIG. 16



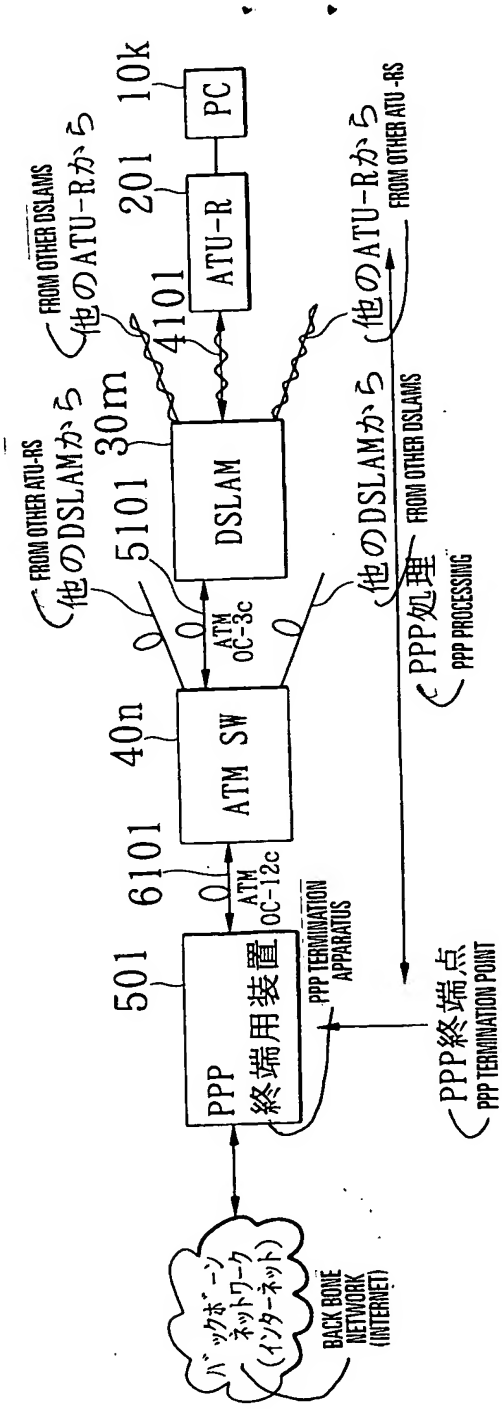
【図１７】
FIG. 17



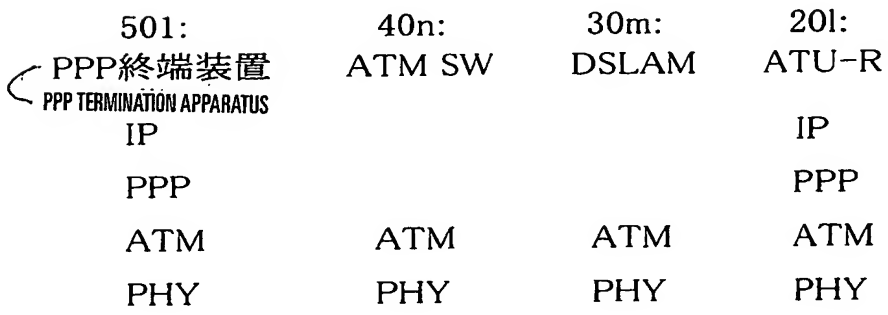
【図１８】
FIG. 18



【図１９】
FIG. 19


PC
10k
ATU-R
201
4101
DSLAM
30m
5101
ATM SW
40n
6101
PPP 終端用装置
501
ATM OC-3c
ATM OC-12c
PPP TERMINATION APPARATUS
PPP終端点
PPP TERMINATION POINT
PPP処理
PPP PROCESSING
他のATU-Rから
FROM OTHER ATU-RS
他のDSLAMから
FROM OTHER DSLAMS
バックボーンネットワーク（インターネット）
BACK BONE NETWORK (INTERNET)

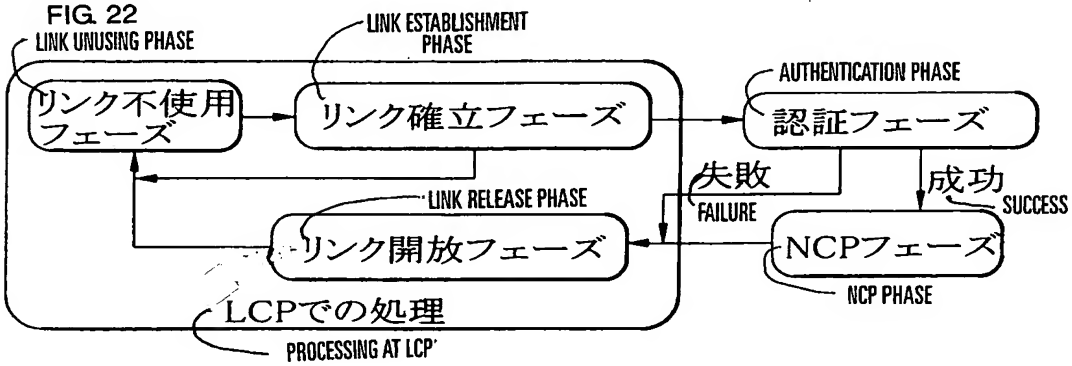
【図２０】
FIG. 20


501:
PPP終端装置
PPP TERMINATION APPARATUS
40n:
ATM SW
30m:
DSLAM
20l:
ATU-R
IP
PPP
ATM
PHY
IP
PPP
ATM
PHY
ATM
PHY

【図２１】
FIG. 21

VALUE OF PROTOCOL FIELD プロトコルフィールドの値	CONTENTS OF PACKET DATA パケットデータの内容
0021	IP
8021	Internet Protocol Control Protocol (Network Control Protocol for IP)
c021	LCP(Link Control Protocol)

【図２２】
FIG. 22



【図２３】
FIG. 23